(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 987 860 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
22.03.2000 Bulletin 2000/12

(51) Int. Cl.[7]: **H04L 12/56**, H04L 29/06

(21) Application number: **99117940.9**

(22) Date of filing: **14.09.1999**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **16.09.1998 JP 26209998**
30.09.1998 JP 29459298
29.10.1998 JP 30922898
29.10.1998 JP 30923198
18.12.1998 JP 36165998

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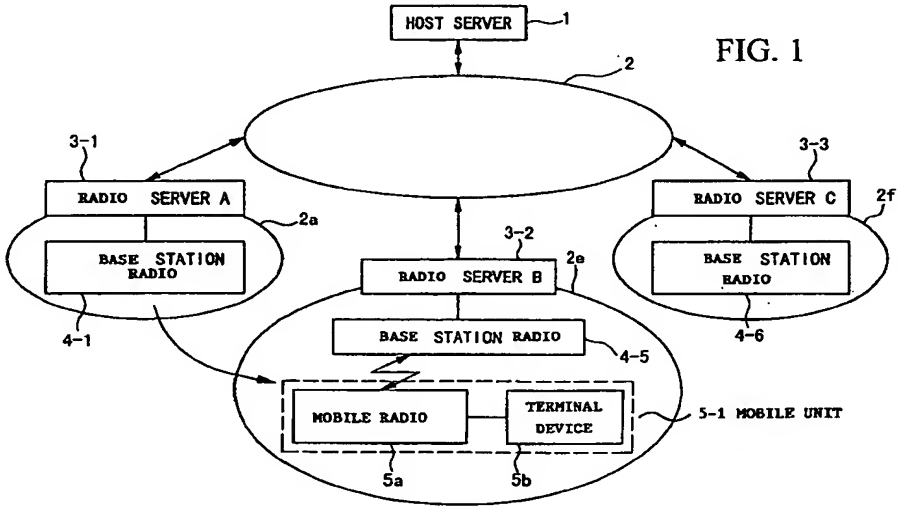
(54) Radio server system

(57) The present invention relates to a radio server system for communicating a user terminal to Internet wirelessly. It is based on a user terminal having a fixed terminal and a mobile unit so that Internet connection can be made by way of the mobile unit to an appropriate radio server. The system has at least one radio server connected to Internet; and a plurality of base station radios connected to the radio server, and the system communicates wirelessly with the mobile unit of the user terminal; wherein one radio server within a district of communication range of the base station radios is designated as a home server for the mobile unit, and the fixed terminal receives data sent wirelessly from Internet by way of the mobile unit.

FIG. 1



EP 0 987 860 A2

Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates in general to radio servers for communicating user terminal devices wirelessly to Internet, and relates in particular to a radio server system that can provide a seamless service to a mobile unit when the mobile unit moves from one managing district to another managing district.

Description of the Related Art

[0002] There has been an increasing need for mobile computing in recent years. Mobile computing performs information processing by connecting to an existing Internet service network through a mobile-phone circuit, for example. A feature of the circuit used for mobile computing is that it enables to communicate from mobile sites by utilizing mobile-phone circuits.

[0003] However, communication devices dependent on the conventional wired communication network operate on communication protocols that are designed for fixed communication services, and present a problem that communication is terminated when a mobile unit moves to a location beyond the capability of sub-net services. Further, there are problems of excessive time of waiting to be connected to the telephone network, and if the line is congested, it may be impossible to secure a line.

SUMMARY OF THE INVENTION

[0004] It is an object of the present invention to provide a communication system that can continue to communicate without using telephone circuits, even when a mobile unit moves out of a sub-net district.

[0005] The object has been achieved in radio server system, for wirelessly connecting a mobile unit having a terminal device and a mobile radio to Internet, comprising: not less than one radio server for communicating with Internet; and a plurality of base station radios connected to the radio server for wireless communication with the mobile unit by way of the mobile radio; wherein one radio server within a district of communication range of the base station radios is designated as a home server for the mobile radio, and the terminal device communicates with Internet by way of the mobile radio.

[0006] An advantage of the present server system is that, because one radio server is designated as the home server for the mobile radio, within a managing district of the home server that can communicate with the mobile radio, and the home server performs the tasks of approving a terminal connection and issuing an IP address, the mobile device is able to carry on communicating in managing districts other than the managing districts of the hole server.

[0007] The object has also been achieved in a mobile radio comprising: a memory section for storing a last operational frequency used by the mobile radio and down-frequencies of a peripheral base station radio; a read-only-memory section for storing permissible operational frequencies for sending and receiving data through the mobile radio; and a judging section for comparing frequencies stored in the memory section and permissible operational frequencies stored in the read-only-memory section, and judging whether or not an operational frequency to be used by the mobile radio is useable; wherein up-frequencies transmitted from the base station radio are tested by using successively the last receiving frequency, the down-frequencies of the peripheral base station radio and the permissible receiving frequencies so that a terminal registration request is transmitted only when an up-frequency received matches with a receiving frequency permitted for the mobile radio.

[0008] An advantage of the present mobile radio is that it is only necessary to search among the down-frequencies of the peripheral station devices to find a useable frequency, because a down-frequency can be selected by the wireless mobile unit for sending a terminal registration request to a radio server.

[0009] Moreover, the reference numbers in the claims have no bearing on the interpretation of the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

Figure 1 is a block diagram of the structure of the wireless network in the Embodiment 1.
Figure 2 is a schematic illustration of the process of the packet transmission in Embodiment 1.
Figure 3 is a flow chart for the process of packet transmission in Embodiment 1.
Figure 4 is a flow chart for the process of packet transmission in Embodiment 1.

Figure 5 is a flow chart for the process of packet transmission in Embodiment 1.
Figure 6 is a flow chart for the process of packet transmission in Embodiment 1.
Figure 7 is an illustration of the steps for issuing addresses in Embodiment 1.
Figure 8 is an illustration of the steps for terminal identification in Embodiment 1.
Figure 9 is an illustration of the steps for terminal identification in Embodiment 1.
Figure 10 is a block diagram of the structure of a radio server B in Embodiment 2.
Figure 11 is a flowchart for the steps taken by a radio server B in Embodiment 2.
Figure 12 is an illustration of the address system used in embodiment 3.
Figure 13 is a block diagram of the structure of the network in Embodiment 4.
Figure 14 is a block diagram of the structure of radio server B for performing simultaneous reporting in Embodiment 4.
Figure 15 is a block diagram of the structure of a mobile unit 5-1 receiving broadcast information in Embodiment 4.
Figure 16 is a flowchart for the operation of a radio server B3-2 shown in Figure 14.
Figure 17 is a flowchart for the operation of the mobile unit 5-1 shown in Figure 15.
Figure 18 is an illustration of a format of broadcast information.
Figure 19 is a block diagram of the structure of a radio server B3-2 for performing multicasting in Embodiment 5.
Figure 20 is a flowchart for the operation of the radio server B3-2 shown in Figure 19.
Figure 21 is a block diagram of the structure of the wireless network in Embodiment 6.
Figure 22 is a block diagram of the structure of the base station radios 4-2~4-4.
Figure 23 is a block diagram of the structure of the mobile unit 5-1.
Figure 24 is a flowchart for the operation of the mobile unit 5-1 shown in Figure 21.
Figure 25 is a block diagram of the structure of a mobile unit 5-1 in Embodiment 7.
Figure 26 is a diagram of the table containing permissible receiving frequencies 27a shown in figure 25.
Figure 27 is an illustration of the priority table 24d shown in Figure 25.
Figure 28 is an illustration of the priority table 24d shown in Figure 25.
Figure 29 is a flowchart for the operation of the mobile unit 5-1 shown in Figure 25.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0011] The following embodiments are presented for illustrative purposes only and are not meant to limit the invention disclosed in the claims. Also, to achieve the objectives, not all the combination of the features presented in the embodiments may be required at all times.

Embodiment 1

[0012] In the following, the radio server system will be presented with reference to the drawings. Figure 1 shows a block diagram of the structure of the system in Embodiment 1. The system includes: a host server 1; a network 2 connected to the host server 1; radio server 3-1~-3 connected to the network 2; sub-networks 2a, 2e, 2f which are managed by the radio servers 3-1~3; and base station radios 4-1, 4-5, 4-6 connected to respective radio servers 3-1~3. Normally, a plurality of immobile base station radios 4-n are connected to one radio server 3-n, but in this illustration, only one station device 4-n is shown for one radio server 3-n. The system serves mobile units represented, in this case, by one mobile unit 5-1, connected to the radio server 3-2 for wireless communication with the base station radios 4-5. The mobile unit 5-1 includes a mobile radio 5a and a computer terminal (referred to hereinbelow as the terminal device) 5b connected to the mobile radio 5a.

[0013] The host server 1 may be a radio server to communicate with the terminal, but it does not necessarily have a wireless communication function.

[0014] Any one of the radio servers 3-n connected to the network 2 can serve as the home server for the mobile unit 5-1. In the diagram shown in Figure 1, the radio server 3-3 is designated as the home server for the mobile unit 5-1.

[0015] Next, the operation of the radio server system of Embodiment 1 will be explained with reference to Figures 1,2,3,4,5 and 6.

[0016] Figure 2 illustrates the operation of the radio server system to manage the movement of a mobile unit. Mailing destination is indicated by "dst" and mailing source is indicated by "src". Figures 3,4,5 and 6 are flowcharts for the operational steps of the radio server system.

[0017] In this case, it is assumed that the home server for the mobile unit 5-1 is the radio server C3-3; and that the mobile unit 5-1 is presently operating under the direction of the radio server A3-1.

[0018] First, the following explanation pertains to the operation of the system when the mobile unit 5-1 moves from sub-network 2a managed by the radio server A3-1 to sub-network 2e managed by the radio server B3-2. The mobile unit 5-1 requests a terminal registration approval and an IP address to radio server B3-2 (refer to (a) in Figure 2, step

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S1 in Figure 3). In response, radio server B3-2 issues registration approval and an IP address (refer to (a), and step S2 in Figure 3), thus enabling the mobile unit 5-1 to operate under the radio server B3-2.

[0019] Processes for approving the terminal registration request and issuing an IP address will be explained later.

[0020] Next, radio server B3-2 notifies the radio server C3-3, which is the home server for the mobile unit 5-1, that the mobile unit 5-1 has moved from the managing district of radio server A3-1 to the managing district of radio server B3-2, and that the terminal registration has been effected (refer to (b) in Figure 2, and step S3 in Figure 3).

[0021] Next, in response to the registration completion report from radio server B3-2, the radio server C3-3, as the home server, notifies radio server A3-1 that the mobile unit 5-1 has moved into the managing district of radio server B3-2 (step S5 in Figure 3). Accordingly, upon receiving the registration completion report from the radio server B3-2 (step S4 in Figure 3), radio server A3-1 stops managing the mobile unit 5-1 (step S6 in Figure 3). In the meantime, while a server C3-3 (home server) records that the mobile unit 5-1 is now in the managing district of B3-2, thereby updating the managing information (step S7 in Figure 3).

[0022] The reason for using the home server C3-3 to notify radio server A3-1 that the mobile unit 5-1 has moved is that, by so doing, the home server will be able to recognize the managing district in which the mobile unit 5-1 is now operating.

[0023] By following the above steps, the mobile unit 5-1 can move about to other managing districts.

[0024] Next, the steps for the host server 1 to transmit a packet to the mobile unit 5-1 will be explained with reference to Figures 2 and 4.

[0025] First, the host server 1 transmits an IP packet through the network 2 (step S11 in Figure 4). At this time, because the host server 1 has not been notified of the movement of the mobile unit 5-1 to managing district B3-2, the packet is sent to radio server A3-1 to which the mobile unit 5-1 had been connected previously (refer to (c) in Figure 2).

[0026] Upon receiving the packet in radio server A3-1 (step S11 in Figure 4), the packet is routed to radio server B3-2 (step S13 in Figure 3, and (d) in Figure 2), and are received by radio server B3-2 (step S14 in Figure 4). Further, radio server B3-2 routes the packet to the mobile radio 5a of the mobile unit 5-1 which is operating within its managing district (step S15 in Figure 4), and the packet is delivered to the mobile radio 5a (refer to (e) in Figure 2), and from there to the terminal device 5b (refer to (f) in Figure 2).

[0027] The packet forwarded from the host server 1 is thus received by the mobile unit 5-1.

[0028] Next, the steps for sending a packet from the mobile unit 5-1 to the host server 1 will be explained with reference to Figures 2,5 and 6.

[0029] First, the terminal device 5b transmits a packet to the mobile radio 5a((g) in Figure 2). Next, the mobile radio 5a transmits the packet to the host server 1 by way of the radio server B3-2 ((h) in Figure 2).

[0030] Next, radio server B3-2 receives the packet (step S21 in Figure 5) and routes the packet to the host server 1 and sends the packet received from the mobile unit 5-1 to the host server 1 ((i) in Figure 2, step S22 in Figure 5).

[0031] Next, the host server 1 receives the packet (step S23 in Figure 5). Upon receiving the packet, the host server 1 now knows that the mobile unit 5-1 is in the managing district of radio server B3-2 because of the source address of the packet (step S24 in Figure 5).

[0032] Therefore, all subsequent packet transmission to the mobile unit 5-1 will be made directly to radio server B3-2.

[0033] Next, the process of sending the packet from the host server 1 to the radio server B3-2 is carried out by first sending the packet to radio server B3-2 ((j) in Figure 2, step S31 in Figure 6).

[0034] Next, the radio server B3-2 receives the packet (step S32 in Figure 6), and routes it to the mobile unit 5-1 (step S33 in Figure 6) and delivers the packet to the mobile radio 5a ((k) in Figure 2), from which the packet is sent to the terminal device 5b ((m) in Figure 2).

[0035] The above manner of informing the host server only when a packet is sent from the mobile unit 5-1 provides an advantage of avoiding congestion of data traffic, because of the elimination of the necessity of informing all the host servers on each move of the mobile unit 5-1.

[0036] Next, the operation of issuing an IP address will be explained with reference to Figure 7.

[0037] First, when the mobile unit 5-1 moves into the managing district of radio server B3-2, it sends an IP address request to the radio server B3-2.

[0038] Next, the radio server B3-2 deduces the home server for the mobile unit 5-1 (radio server C is the home server in this case), and sends an IP address request to the radio server C3-3.

[0039] Next, an IP address allocation request is made to DHCP radio server 6-3, which is a radio server for issuing IP addresses and is connected to the radio server C3-2 (home server). In response, DHCP radio server 6-3 issues an IP address presently available for use, and the radio server C3-3 is informed of the IP address issued.

[0040] Next, the radio server C3-3 forwards the issued IP address to the mobile unit 5-1 by way of the radio server B3-2.

[0041] In this process, if the radio server B3-2 is the home server for the mobile unit 5-1, an IP address is obtained directly from DHCP radio server 6-2.

[0042] The above process of issuing an IP address provides an advantage that even when the mobile unit 5-1 is oper-

ating under the managing district of radio server B3-2, an IP address issued by the radio server C3-3 can be used as though the mobile unit 5-1 is operating in the managing district of radio server C3-3, so that the packet transmission to the mobile unit 5-1 is allowed to be carried out by way of the radio server B3-2.

[0043] Next, the process of approving a terminal registration request will be explained with reference to Figures 8 and 9.

[0044] First, the mobile unit 5-1 sends a terminal registration request and its identifier number to the radio server B3-2 ((a in Figure 9).

[0045] Next, the radio server B3-2 searches in the database 7-2 connected to the radio server B3-2 to find out whether or not the identification data of the mobile unit 5-1 is included. If the identification data do not exit in the database 7-2, the radio server B3-2 judges that it is not the home server for the mobile unit 5-1, and deduces the home server for the mobile unit 5-1 according to the identifier number received, and transfers the approval request to the home server (in this case, radio server C3-3) ((b) in Figure 9).

[0046] At this time, if the home server cannot be deduced from the identifier number of the mobile unit 5-1 received, the terminal registration request is sent to a pre-determined radio server (radio server A3-1, in this case). If the identifier number is not included in the database 7-1 of radio server A3-1, the terminal registration request is sent to a predetermined radio server (radio server (C3-3, in this case). These actions are repeated until the home server of the mobile unit 5-1 is notified of the terminal registration.

[0047] In the above process, the registration request is accompanied by the identifier number of the mobile unit 5-1 and a random number generated by the radio server B3-2. This random number is sent to the mobile unit 5-1 also ((c) in Figure 9).

[0048] Next, the radio server C3-2 which is the home server for the mobile unit 5-1 receives the approval request, and performs an approval computation using the random number and the identifier number received from the radio server B3-2.

[0049] Next, the radio server C3-3 returns the result of approval computation to the radio server B3-2 (d) in Figure 9).

[0050] In the meantime, the mobile unit 5-1 performs an approval computation using the random number received from the radio server B3-2, and returns the result to the radio server B3-2((e) in Figure 9).

[0051] Next, the radio server B3-2 compares the results of approval computation received from the radio server B3-2 and the mobile unit 5-1 ((f) in Figure 9). Then, when the check process shows that the two are identical, the registration request is approved ((g) in Figure 9). If the check reveals that the two are not identical, it regards that the registration request is improper, and denies the approval request.

[0052] On the other hand, if the identification data exist in the database 7-2, the radio server receiving the approval request is the home server for that mobile radio, therefore, approval operation consists only of "registration request" ((a) in Figure 9), "approval request" ((c) in Figure 9), "approval response" ((e) in Figure 9), "registration acceptance" ((g) in Figure 9).

[0053] Accordingly, approval for a terminal registration for the mobile unit 5-1 can be carried out even when the mobile unit 5-1 is not under the managing district of a radio server which is its home server.

Embodiment 2

[0054] Next, the operation of the radio server B3-2 in issuing an IP address will be explained in more detail.

[0055] Figure 10 shows a block diagram of the structure of the radio server B3-2 including a network connection section 3a for connecting to the network 2; a relay agent section 3b for sending an address request to DHCP radio server 6-3, in response to an IP address request sent from the mobile unit 5-1, and receiving the IP address issued by DHCP radio server 6-3; a terminal connection section 3c for establishing communication with the mobile unit 5-1 by way of the base station radio 4-5; and a home server defining section 3d for defining the home servers for individual mobile radios.

[0056] Next, the process of issuing an IP address from the radio server B3-2 will be explained with reference to Figures 10, 11. Figure 11 shows a flowchart showing the steps taken by the radio server B3-2.

[0057] First, the terminal connection section 3c in the radio server B3-2 receives an IP address request sent from the mobile unit 5-1 by way of the base station radio 4-5 (step S41). At this time, the mobile unit 5-1 broadcasts (meaning sending the same packet simultaneously to all the devices connected within the network) the IP address request. In response, the radio server B3-2 judges whether the IP address request is from the mobile unit 5-1, and if it is, the IP address request is accepted.

[0058] The IP address request packet includes the identifier ID for the mobile unit 5-1 that is sending the request. The identifier ID is a media access control (MAC) address belonging to the mobile unit 5-1. A MAC address is an identifier number allocated to the hardware of the mobile unit 5-1.

[0059] Next, when the received packet is an IP address request from the mobile unit 5-1, the terminal connection section 3c forwards the received packed to the relay agent section 3b.

[0060] Then, the relay agent section 3b extracts from its content the identifier ID of the mobile unit 5-1, and by con-

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sulting the contents of the home server defining section 3d, deduces an identifier ID to correspond to the mobile radio making the request (step S42).

[0061] The home server defining section 3d is provided with a table relating identifiers IDs of individual mobile unit 5-1 and the IP addresses of home servers of mobile unit 5-1 corresponding to the identifier IDs. By consulting the table, the relay agent section 3b deduces the IP address of the home server for the mobile unit 5-1 having the identifier ID received therein.

[0062] Next, the relay agent section 3b sends an IP address request packet on behalf of the mobile unit 5-1 to the home server (radio server C3-3 in this case) through the network connection section 3a (step S43). At this time, the source address of the sent packet is the IP address of the radio server B3-2, and the destination address is the IP address of the deduced home server.

[0063] Here, if the data of the mobile unit 5-1 do not exist the home server defining section 3d of the radio server B3-2, i.e., when the home server cannot be deduced from the received identifier ID, the IP address request is sent to a pre-determined radio server (A-3, in this case). If the data do not exist in the home server defining section 3d of the second radio server, the IP address request is sent to another pre-determined radio server (C3-3, in this case). By repeating the steps until the home server of the mobile unit 5-1 is found, the IP address request is delivered to the home server of the mobile unit 5-1. Accordingly, a home server for a mobile unit can be deduced under any circumstance.

[0064] Next, the radio server C3-3 receiving the IP address request packet sends an IP address request to the DHCP radio server 6-3. In response to the request, the DHCP radio server 6-3 issues an IP address presently available for use, and sends it to the radio server C3-3. In response, the radio server C3-3 sends the packet containing the IP address issued by the DHCP radio server 6-3 to the radio server B3-2 that sent the IP address request packet.

[0065] Next, the network connection section 3a receives the packet sent by the radio server C3-3 (step S44). The network connection section 3a judges whether the received packet is a response packet replying to the IP address request, and when it is the response packet, the packet is forwarded to the relay agent section 3b.

[0066] Next, the relay agent section 3b receiving the response packet from the network connection section 3a attaches the identifier ID of the mobile unit 5-1, and forwards the packet to the terminal connection section 3c.

[0067] Next, the terminal connection section 3c distributes the response packet to the mobile unit 5-1 broadcasting (step S45). Then, the mobile unit 5-1 checks whether the identifier ID is included in the broadcast packet for the mobile unit 5-1, and if it is contained, the mobile unit 5-1 extracts the IP address from the packet.

[0068] The process of issuing an IP address to mobile unit 5-1 presently requesting an IP address, from a radio server that is not the home server provides an advantage that any mobile unit is able to access any other radio servers without changing the settings of the IP address of the mobile unit 5-1.

[0069] Also, normal broadcasting systems do not allow a mobile unit to broadcast beyond own network (with which it is presently communicating) to other mobile units connected to other networks. However, the present broadcast system allows an IP address request to be made to a DHCP radio server connected to any network, because of the provision of a relay agent section for sending/receiving an IP address request packet on behalf of the mobile unit.

Embodiment 3

[0070] Next, an address band system for the radio server B3-2, base station radios 4-2~5 and the mobile radio 5a will be explained with reference to Figure 12. In Figure 12, IP address for the radio server B3-2 is assumed to be, for example, [172.31.0254], and the IP addresses for the base station radios 4-2~5 to be [172.31.31.254], [172.31.47.254], [172.31.63.254][172.31.79.254], respectively.

[0071] Also, an IP address of one mobile radio 5a among the many mobile radios communicating with the base station radios 4-2~5 is assumed to be [172.31.0.1].

[0072] An IP address is usually expressed in 32-bits and decimal notation, and each group of 8-bits is separated by a period [.].

[0073] In the following explanation, the numerals separated by [.] are referred to, from the left, as first numeral, second numeral, third numeral and fourth numeral.

[0074] The third numerals [31], [47], [63], and [79], in the base station radios 4-2~5, are expressed so that the higher 4-bits are [0001], [0010], [0011], [0100] and all the lower bits are [1111]. Also, the third and fourth numeral for all the base station radios are pre-selected for each device by the respective radio server. As an example, all the base station radios can be expressed as [11111110] (representing 254 in decimal notation). The lower 4-bits in the third numeral and the numeral [1111 1111 1110] represented by the fourth numeral indicate that this device is a base station radio, and the upper 4-bits in the third numeral distinguish individual base station radios.

[0075] Also, the first numeral and the second numeral represent the radio server B3-2 to which the base station radios 4-2~5 are connected.

[0076] Such designations by IP addresses allow to identify a radio server connected to each of the base station radios 4-2~5 as well as to identify the numerical order of the devices within the station.

[0077] With respect to identifying the mobile radio 5a, the lower 12-bits of the 32-bit IP address are assigned by the radio server B3-2. Therefore, it is possible to know to which base station radio the mobile radio 5a is connected, by selecting an IP address for the mobile radio 5a according to the IP addresses assigned to the radio server B3-2 and the base station radios 4-2~5.

[0078] Accordingly, by providing IP addresses to the base station radios, and using integrated services digital network (ISDN) routers A, B for the communication between the radio server B3-2 and the base station radio 4-3, communications can be carried out regardless of how far apart the radio server B3-2 is from the base station radio 4-3, without changing the configuration shown in Figure 12.

[0079] As explained above, by proving a radio server as home server for terminal devices, and providing terminal identifying means and terminal managing means to the radio server to that terminal connection approval and IP address issuing can be performed by the home server, communications are possible even when the terminal device is located in managing districts other than the district managed by the home server.

[0080] Also, in the present system, an IP address request made from a terminal device to a radio server, which is not the home server for the terminal device, is processed through its home server by way of the presently communicating radio server, therefore, it is possible to contact other radio servers without changing the settings of the IP address of the terminal device.

[0081] Also, the above manner of informing the host server only when packet transfer occurs from the wireless mobile unit provides an advantage of avoiding congestion of data traffic, because of the elimination of the necessity of informing all the host servers for each move of the mobile unit 5-1.

[0082] Also, IP addresses are allocated also to the base station radios so that the Internet protocol and ISDN routers can be used for communicating between the terminal devices and the radio server, thereby enabling the communications to be maintained regardless of the separation distance between the radio server and the base station radios, without having to alter the configuration of the system.

Embodiment 4

[0083] Next, the operating of broadcasting information to individual wireless mobile unit 5-1 will be explained in the following.

[0084] Figure 13 shows a block diagram of the overall structure of the system including: a broadcasting terminal 1a for preparing and broadcasting information; a radio server B3-2 connected to the terminal 1a by a network 2; four base station radios 4-2~5 connected to the radio server B3-2; and individual mobile units 5-1~4 communicate with the respective base station radios 4-2~5.

[0085] It should be noted that although four base station radios 4-2~5 for the radio server B3-2 are shown in the drawing, any number of devices may be connected as needed.

[0086] Also, one mobile unit 5-1 is shown for each base station radio 4-2, for example, one station device may communicate with more than two mobile unit 5-1.

[0087] Next, broadcasting operation from the broadcasting terminal 1a will be explained with reference to Figure 13. Broadcasting means distributing the same information to a plurality of terminal devices simultaneously.

[0088] First, the operator prepares information for broadcasting using the terminal 1a.

[0089] An example of the broadcasting format is shown in Figure 18. As shown in this illustration, broadcasting information is comprised by a header section and a plurality of information. In this case, it is assumed that the information is divided into four sections.

[0090] In the header section are included, an identifier to indicate that the information is to be broadcast, network addresses for delivery of information, and sizes of the information files 1~4 that follow the header section.

[0091] It is rarely necessary that the same information be broadcast to all the mobile units 5-1, so that the broadcast information is divided into a plurality of reception levels according to the subject matter. In the example shown in Figure 18, the information is divided into four groups.

[0092] Dividing according to the reception levels can be explained using an example of broadcasting an emergency message according to the type of terminal devices as follows: those belonging to individual persons (level 1), those belonging to self-governing bodies (level 3), those belonging to fire departments (level 7), and those belonging to police (level 15).

[0093] Accordingly, the terminals receiving broadcasting information are divided into pre-arranged reception levels, and are identified by the level numbers (referred to as broadcast levels).

[0094] In the example shown in Figure 18, bits are assigned to information 1~4 to indicate the broadcast levels, so that when the bit is [1], the information is needed by the terminal having this level number. Information 1 is allocated to the lowest bit and information 4 is allocated to the highest bit.

[0095] For example, for those terminals requiring only information 1, only the lowest bit is [1] so that the level number is [1]. For those terminals requiring all the information 1~4, all four bits are [1] so that the level number is [15]. For those

terminals requiring no information, level number is [0].

[0096] Accordingly, if there are four groups of information, there will be sixteen types of broadcast levels with level numbers ranging from [0] to [15].

[0097] Also, even when there is a large quantity of information to be broadcast, bit number can be increased to increase the number of levels.

[0098] Broadcast information is prepared by separating the information into a plurality of levels according to the broadcast levels.

[0099] Next, broadcasting terminal 1a broadcasts the prepared information to a specified network 2. The network to be broadcast is not limited to the network connected to the broadcasting terminal 1a, but can be selected by specifying other network addresses.

[0100] The broadcasting terminal may be constructed using a computer device having input/output means.

[0101] Next, the operation of the radio server B3-2 for distributing the broadcast information to the mobile units 5-1~4 will be explained with reference to Figures 14, 16.

[0102] Figure 14 shows a block diagram of the structure of the radio server B3-2, and Figure 16 shows a flowchart of the steps taken by the radio server B3-2.

[0103] First, a broadcast information receiving section 3e provided in the radio server B3-2 receives broadcast information distributed by the broadcasting terminal 1a (step S46) and stores this information in a broadcast information receiving section 3e.

[0104] At this time, the broadcast information receiving section 3e judges whether or not this is broadcast information depending on whether or not the identifier is included in the header to indicate that it is broadcast information.

[0105] Then, the broadcast information reconstruction section 3f accesses the information stored in the broadcast information receiving section 3e, while consulting the broadcast level defining section 3i, and reconstructs broadcast information so as to match the broadcast levels of the connected mobile units 5-1~4 (step S47).

[0106] Reconstruction of broadcast information means that the types of information not needed by the mobile unit 5-1 are eliminated so that the mobile units 5-1~4 may receive only the necessary information.

[0107] Also, in the broadcast level defining section 3i, there are defined the level numbers of the broadcast levels and communication channels of the mobile units 5-1~4 presently communicating with the radio server B3-2.

[0108] Next, the channel selection section 3g refers to the broadcast level defining section 3i, and selects channels to correspond to the individual mobile units 5-1~4 (step S48) and forwards the reconstructed broadcast information to a sending section 3h.

[0109] Next, the sending section 3h transmits the broadcast information through a channel selected by the channel section 3g to the individual mobile units 5-1~4 (step S49).

[0110] In this case, if packet communication channels are already established between the radio server B3-2 and the mobile units 5-1~4, the channel selection section 3g may transmit the packets by changing the receiver addresses to the addresses of the mobile unit 5-1.

[0111] Accordingly, because the radio server B3-2 receives the grouped broadcast information, the radio server B3-2 reconstructs broadcast information according to the broadcast levels of the mobile units 5-1~4, and transmits only the relevant information to the mobile units 5-1~4, so that the system can operate more efficiently.

[0112] Next, the process of selecting broadcast information by the mobile unit 5-1 will be explained with reference to Figures 13, 15 and 17.

[0113] Figure 15 shows a block diagram of the structure of the mobile unit 5-1, and Figure 17 shows a flowchart of the steps taken by the mobile unit 5-1.

[0114] The operation of the mobile unit 5-1 will be explained with reference to Figures 15 and 17.

[0115] First, as described above, broadcast information is prepared by the broadcasting terminal 1a, and the information is broadcast within the network 2. Then, the radio server B3-2 receiving the broadcast information distributes the information in the as-received condition.

[0116] In the following explanation, because the operation is the same for all the mobile units 5-1~4, mobile unit 5-1 is chosen as the representative terminal.

[0117] When broadcast information is delivered from the radio server B3-2, the receiving section (mobile device) 5a provided in the mobile unit 5-1 receives this information (step S51), and holds it in the receiving section 5a.

[0118] At this time, the receiving section 5a recognizes whether or not the information is broadcast information according to whether or not the broadcast identifier is included in the header section.

[0119] Next, the information extraction section 5b accesses the broadcast information stored in the receiving section 5a, while consulting the broadcast level defining section 5d, and extracts only the necessary information for the mobile unit 5-1 (step S52).

[0120] At this time, because the broadcast level of the mobile unit 5-1 is defined in the broadcast level defining section 5d shown in Figure 15, only the necessary information is extracted from the broadcast information.

[0121] Next, the information extraction section 5b displays the extracted information on a display section 5c (step

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S53).

[0122] Accordingly, only the necessary information for the mobile unit 5-1 is displayed on the display section 5c provided on the mobile unit 5-1.

[0123] As described above, only the information required by the mobile unit 5-1 is extracted from the broadcast information so that the information processing efficiency is improved.

[0124] Also, because the process of information classification is carried out according to the broadcast level provided in the mobile unit 5-1, the broadcasting terminal can select what information to be delivered to a mobile unit 5-1, thus improving the information delivery efficiency.

[0125] It should be noted that although the system operation is exemplified by the use of wireless communication, terminal devices communicating with the radio server B3-2 may include wired devices. Also, the terminal configuration shown in Figure 15 can be applied to wired devices.

[0126] It should be noted also that the mobile unit 5-1 shown in Figure 12 may communicate directly with a network 2.

[0127] It should also be noted that broadcast information is not limited to text data, other types of data such as audio data and customized signals are also applicable. In such cases, the display section 5c shown in Figure 15 may be replaced with a speaker device for generating sounds, or an alarm device for generating an alarm sound in response to customized signals.

Embodiment 5

[0128] Embodiment 5, relating to a multi-cast system in which same information is distributed to a plurality of mobile units 5-1, will be explained with reference to Figures 1, 13, 19 and 20. In contrast to broadcasting which transmits the same information simultaneously to all the mobile units 5-1, multi-casting transmits the same information simultaneously to specified mobile units.

[0129] Figure 19 shows a block diagram of the structure of the radio server B3-2, which includes: a multi-cast information receiving section 3j which received information through a network 2; a destination deciding section 3k for determining the delivery destinations; a sending section 3m for sending received information to the mobile unit 5-1; and a terminal information memory section 3n for storing information on home server of the mobile unit 5-1 and a radio server presently being connected.

[0130] Figure 20 shows a flowchart of the steps of distributing multi-cast information to the mobile unit 5-1.

[0131] It is assumed that the mobile unit 5-1 to communicate with the radio server A3-1, radio server B3-2, the radio server C3-3 shown in Figure 1 have been classified into groups for receiving multi-cast information, and are provided with group identifiers ID. The group IDs are managed by the home servers for each of the mobile units 5-n, and a client table containing terminal IDs and group IDs for the mobile unit 5-n is included in the terminal information memory section 3n of each home server.

[0132] First, the mobile unit 5-1 transmits a terminal registration request to the radio server B3-2. At this time, the mobile unit 5-1 transmits its terminal ID. In response, the radio server B3-2 carries out terminal registration process as described earlier. Then, the radio server B3-2 reports particulars of the mobile unit 5-1 to the home server (in this case radio server C3-3), which registers this information. By this process, the home server (radio server C3-3) is able to obtain an identification of the radio server presently communicating with the mobile unit 5-1 that is requesting a terminal registration, and the group ID of the mobile unit 5-1.

[0133] Next, when the registration process is completed, the home server reports to the radio server B3-2 the group ID of the mobile unit 5-1 registered presently. Upon receiving the group ID, the radio server B3-2 registers the group ID in the terminal information memory section 3n.

[0134] Accordingly, this process results in the terminal information memory section 3n in the radio server B3-2 to store a plurality of group IDs for those mobile units 5-n whose home server is the radio server B3-2 as well as those mobile unit 5-n whose home servers are other radio servers located in other terminal managing districts.

[0135] Next, the operation of the radio server B3-2 to receive a multi-cast packet from a mobile unit 5-1 and multi-casts the packet to specified mobile unit 5-1, will be explained in the following.

[0136] First, a mobile unit 5-n prepares multi-cast packet. The packet contains an identifier to indicate that the information is to be multi-cast, and address of the destination network and group ID for information distribution. The packet is then transmitted to the destination network. It should be noted that the mobile unit 5-n preparing multi-cast information can be connected to any network and the information can be delivered to any destination network.

[0137] Next, the information receiving section 3j provided in the radio server B3-2 receives multi-cast information (step S61). At this time, the information receiving section 3j judges whether or not the information is multi-cast information on the basis of whether or not the identifier ID indicating multi-casting is included in the header. The received multi-cast information is stored in the information receiving section 3j.

[0138] Next, destination deciding section 3k accesses the multi-cast information stored in the information receiving section 3j, while consulting the contents of the memory of the terminal information memory section 3n, to decide the

delivery destination (step S62). At this time, the destination deciding section 3k selects mobile units for packet delivery, by extracting the group ID contained in the multi-cast information, and extracting those mobile units having the same group ID by referring to the content of the terminal information memory section 3n. Packet delivery is made to those terminals that are presently communicating with the radio server B3-2 if they have the same group ID. If they are not presently communicating, delivery is made later when they are connected.

[0139] On the other hand, if a mobile unit 5-1 whose home server is the radio server B3-2 is presently communicating with another radio server and has the same group ID for multi-casting delivery, the destination deciding section 3k deduces the radio server which is presently communicating with the mobile unit 5-1, and designates this radio server to be a packet delivery destination.

[0140] Next, when the delivery destination has been decided, the destination deciding section 3k transmits multi-cast information received in the information receiving section 3j to individual mobile units 5-n through the sending section 3m (step S63).

[0141] Accordingly, the features of this system are that the reference is made to the terminal information memory section 3n to decide the mobile units for receiving multi-cast information, and that the reliability of information delivery is assured because multi-cast information can be transferred to the correct destination, even when the mobile unit 5-1 is connected to another radio server.

[0142] It should be noted that the processes described in flowcharts shown in Figures 3, 4, 5, 6, 11, 16, 19 and 20 can be carried out by application programs recorded on a computer readable memory medium, and executing the program by a computer system. Computer system, in this context, includes any operating systems and peripheral hardwares that are connected (remotely or directly) to networks. Computer-readable recording media include portable media such as floppy discs, opto-magnetic discs, ROM, CD-ROM, as well as fixed devices such as hard discs housed in computer systems.

[0143] Computer-readable recording media include short-term dynamic memories used in transmitting programs and data through communication circuits such as Internet or telephone circuits, as well as other short-term memories such as volatile memories used in servers and client computer systems. Application program may perform a part of the described functions, or may be operated in conjunction with pre-recorded programs stored in computer systems.

[0144] In other words, a computer-readable recording medium containing a relay agent program for processing an IP address request should include functions so that the computer can execute tasks such as: processing an IP address request from a mobile radio; deducing a home server of the requesting wireless mobile according to a request content; issuing an IP address request on behalf of the requesting mobile radio; receiving an IP address issued by the home server; and distributing the received IP address to the requesting mobile radio.

[0145] Also, a computer-readable recording medium containing a terminal connection program for processing a terminal connection request should include approval functions so that the computer can execute tasks such as: identifying a terminal in response to a terminal registration request; issuing an IP address that is presently available for use.

[0146] Also, the terminal connection program should further include packet transfer functions so that the computer can execute a task that, when a terminal device moves from a previously-connected radio server to a presently communicating radio server that is not its home server, and packet data addressed to the terminal device are delivered to the presently communicating radio server that is not its home server, then the packet data are routed to the presently communicating radio server according to the IP address obtained from the home server of the subject terminal device.

[0147] Also, the terminal connection program should further include routing functions so that the computer can execute a task that, when the subject terminal device is presently communicating with a radio server that is not its home server, and packet data are transferred to the wireless terminal, a host server on the Internet that routed the packet data is advised of the identity of the presently communicating radio server so that subsequent packet data are routed to the presently communicating radio server.

[0148] Also, a computer-readable recording medium containing a broadcasting program for distributing information should include broadcasting functions so that the computer can execute tasks such as: receiving distributed broadcast information; extracting from the received broadcast information only the necessary information for the subject terminal device, while consulting the contents of the broadcast level defining section; and displaying only the required information on a display section of the subject terminal device.

[0149] Also, a computer-readable recording medium containing a multi-cast program for distributing information should include multi-casting functions so that the computer can execute tasks such as: receiving multi-cast data; deciding distribution destinations for the multi-cast data by consulting terminal information; and distributing multi-cast data according to decided delivery destinations.

[0150] Furthermore, the present radio server system enables a mobile unit to continue to communicate in different managing districts so that this technologies can be utilized in the field such as: messages (such as e-mail, netnews, file transfer protocol (FTP)), voice mail, web broadcasting, computer telephony integration (CTI), information broadcasting, telemetering, intelligent transport system (ITS). Also, the system is applicable to the push-technology when used in conjunction with routing functions.

Embodiment 6

[0151] The base station radio 4-n and the mobile unit 5-1 shown in Figure 1 will be explained with reference to Figures 21-24.

[0152] Figure 21 shows a block diagram of the overall configuration of the radio server system which includes: a radio server B3-2; a plurality of base station radios 4-2~5, wire-connected to the radio server B3-2 using sending frequencies f1~f3; a mobile unit 5-1 for wireless communication with the base station radio 4-5 which uses a sending frequency f0. The mobile unit 5-1 is comprised by a mobile radio 5a and a terminal device 5b and uses a sending frequency F0.

[0153] In the following explanation, the sending frequencies f0~f3 of the base station radios 4-2~5 are termed the down-frequencies, and the sending frequency F0 of the mobile radio is termed the up-frequency.

[0154] Figure 22 shows a block diagram of the configuration of the base station radios 4-2~5 comprised by: a server data receiving section 11 for receiving data sent from the radio server B; a memory section 12 for storing the data received in the server data receiving section 11; a ROM 13 for storing operational frequencies containing a plurality of values of up-frequency 13a and down-frequency 13b; judging sections 14, 15 for comparing data sent from radio server B with data stored in ROM of a base station radio 4-n, and output results of comparison; a sending data preparation section 17 for receiving results of the judging sections 14, 15 and preparing sending data to be sent from the station device 4-n; a modulation section 17 for modulating the data; and a signal output section 18 for sending the modulated data produced by the modulation section 17.

[0155] Fig. 23 shows a block diagram of the configuration of the mobile unit 5-1 shown in Figure 21 comprised by: a signal receiving section 21 for receiving signals sent from the base station radio 4-n; a demodulator 22 for demodulating the received data; a received signal analysis section 23; a memory section 24 for storing the operational frequencies; a frequency selection section 25 for selecting receiving frequency; a priority setting section 26 for selecting the order of receiving frequencies by the frequency selection section; a ROM 27 for storing frequencies that can be received by the mobile unit 5-1; and judging section 28 for judging the sending frequency that can be used by the mobile unit 5-1.

[0156] The operation of the radio server B3-2, base station radios 4-2~5, and the mobile unit 5-1 will be explained with reference to the drawings. In this case, base station radio 4-5 is used as an example.

[0157] First, the radio server B3-2, managing the base station radios 4-2~5, informs each of the base station radios 4-2~5 what operational frequency can be used. At this time, the radio server B3-2 transmits the same information to all the base station radios 4-2~5, thereby enabling the base station radios 4-2~5 to know the operational frequencies of the other base station radios.

[0158] Next, the operation of the base station radios 4-5 will be explained.

[0159] The server data receiving section 11 provided in the base station radio 4-5 receives the down-frequency information sent by the radio server B-3-2. Then, the server data receiving section 11 stores the received information in the memory section 12. Then, the server data receiving section 11 stores data received by the peripheral base station radios (in this case, base station radios 4-2~4) separately as up-frequency 12a for peripheral base station radios, up-frequency 12b and down-frequency 12c for own device.

[0160] Next, the judging section 14 compares up-frequency 13a stored in ROM 13 with own up-frequency 12b stored in the memory section 12. If the result shows that the own up-frequency 12b sent from the radio server B3-2 is a permissible frequency, this up-frequency 12b is forwarded to the sending data preparation section 16.

[0161] In parallel with the above process, the judging section 15 compares down-frequency 13b stored in ROM 13 with the own down-frequency stored in the memory section 12. If the result shows that the own down-frequency 12c sent from the radio server B3-2 is a permissible frequency, the down-frequency 12c is forwarded to the sending data preparation section 16 and the modulation section 17.

[0162] Next, the sending data preparation section 16 converts up- and down-frequency information received from the judging sections 14, 15 to sending data. Concurrently, the sending data preparation section 16 converts information regarding the down-frequencies 12a for the peripheral base station radios to sending data. Then, the sending data preparation section 16 forwards the converted sending data to the modulation section 17.

[0163] Next, the modulation section 17 uses the down-frequency received from the judging section 15 to modulate the sending data prepared by the sending data preparation section 16. The modulated sending data are sent from the signal sending section 18.

[0164] Next, the operation of the mobile unit 5-1 will be explained. Figure 24 shows a flowchart of the steps taken by the mobile unit 5-1.

[0165] First, the demodulation section 22 uses a receiving frequency 24b stored in the memory section 24 to attempt to receive signals from the signal receiving section 21 (step S101). This receiving frequency 24b is the frequency which was last-used for communication.

[0166] Next, it is examined whether the signal reception by the demodulator 22 was successful (step S102), and if successful, the received signal is demodulated and is forwarded to the received signal analysis section 23.

[0167] Next, the received signal analysis section 23 analyzes the received signal, and stores the down-frequency of

the peripheral base station radio in the memory section 24 and obtains up-frequency (step S103) which is forwarded to the judging section 28.

[0168] Next, the judging section 28 accesses the permissible sending frequencies 27b stored in ROM 27, and compares with the up-frequency received from the received signal analysis section 13, and checks whether the up-frequency received is permissible for signal transmission (step S104). This judgment is based on whether the received up-frequency matches the sending frequencies 27b stored in ROM 27. If the result indicates that it can be sent, the judging section 28 stores the up-frequency in the memory section 24. Then, the modulation section 29 uses the sending frequency 24a stored in the memory section 24 to send the registration request from the mobile unit 5-1 (step S105). Also, when there is no need for sending the terminal registration, it is possible to eliminate the step of sending the request.

[0169] The registration request is sent by having the modulation section 29 access the sending frequency stored in the memory section 24, and sending the signal from the signal sending section 30 at this frequency.

[0170] Accordingly, when the mobile wireless terminal has not moved, the use of the last-used frequency to obtain the up-frequency enables to commence communication without performing the frequency selection step.

[0171] On the other hand, if signal reception is not possible in step S102 and if the up-frequency is not a permissible frequency in step S104, the selection section 25 checks the down-frequencies 24c of the peripheral base station radio stored in the memory 24, and selects a receiving frequency according to the priority order stored in the priority setting section 26 (step S106). At this time, the selection section 25 compares the selected receiving frequency with the permissible receiving frequencies stored in the memory 27, and if the selected receiving frequency is a permissible frequency, this frequency is stored in the memory section 24.

[0172] Next, the demodulation section 22 uses the receiving frequency 24b stored in the memory section 24 to check whether the signal reception was successful (step S107), and if it was successful, received signal is demodulated which is forwarded to the received signal analysis section 23.

[0173] Next, the received signal analysis section 23 analyzes the received signal, and stores peripheral down-frequency in the memory section 24, and concurrently, obtains the up-frequency (step S108) which is forwarded to the judging section 28.

[0174] Next, the judging section 28 accesses the permissible sending frequencies 27b stored in ROM 27, and compares them with the up-frequency received from the received signal analysis section 23, and checks whether the up-frequency received is permissible for signal sending (step S109). This judgment is based on whether the received up-frequency matches the sending frequencies 27b stored in ROM 27. If the result indicates that it can be sent, the judging section 28 stores the up-frequency in the memory section 24. Then, the modulation section 29 uses the sending frequency 24a stored in the memory section 24 to send the registration request from the mobile unit 5-1 (step S105). Also, when there is no need for sending the terminal registration, it is possible to eliminate the step of sending the request.

[0175] Next, if the signal reception was not possible in step S107 and if the up-frequency is not the permissible frequency in step S109, steps S106~S109 are repeated (step S110).

[0176] Next, in step S110, if there are no other candidates for the permissible down-frequencies, the selection section 25 checks the permissible receiving frequencies 27a stored in ROM 27, and selects a receiving frequency according to the priority order stored in the priority order setting section 26 (step S111), which is stored in the memory section 24.

[0177] Next, the demodulation section 22 uses the receiving frequency 24b stored in the memory section 24 to check whether the signal reception was successful (step S112), and if it was successful, received signal is demodulated which is forwarded to the received signal analysis section 23.

[0178] Next, the received signal analysis section 23 analyzes the received signal, and stores peripheral down-frequency in the memory section 24, and concurrently, obtains the up-frequency (step S113) which is forwarded to the judging section 28.

[0179] Next, the judging section 28 accesses the permissible sending frequencies 27b stored in ROM 27, and compares them with the up-frequency received from the received signal analysis section 23, and checks whether the up-frequency received is permissible for signal sending (step S114). This judgment is based on whether the received up-frequency matches the sending frequencies 27b stored in ROM 27. If the result indicates that it can be sent, the judging section 28 stores the up-frequency in the memory section 24. Then, the modulation section 29 uses the sending frequency 24a stored in the memory section 24 to send the registration request from the mobile unit 5-1 (step S105). Also, when there is no need for sending the terminal registration, it is possible to eliminate the step of sending the request.

[0180] Next, if signal reception was not possible in step S112 or if the up-frequency is not the permissible frequency in step S114, steps S111~S114 are repeated (step S115). Next, in step S115, if there are no other permissible receiving frequencies, the mobile unit 5-1 is not able to use the present managing district so that it is necessary to move to another managing district, and attempt the steps shown in Figure 24.

[0181] Also, when the base station radio 4-5 shown in Figure 21 has commenced communicating with another mobile unit, the mobile unit 5-1 is in a standby state. In this condition, if the mobile unit 5-1 tries to send a packet to the radio server B3-2, the base station radio 4-5 cannot be accessed. In such a case, the mobile unit 5-1, using a receiving frequency of a peripheral station device (base station radio 4-2~4, in this case) obtained in step S101 (Figure 24) and

stored in the memory section 24, acquires a sending frequency of the base station radio 4-4-2 by following the steps S106~S109. This approach permits the mobile unit 5-1 to communicate immediately with the base station radio 4-4-2 without changing the radio server B3-2, thus eliminating the necessity for the step of terminal registration (Figure 24).

[0182] Further, if the steps S106~S109 are carried out while the mobile unit 5-1 is in the standby state, a packet can be sent out immediately without having to receive a new sending frequency of the base station radio 4-2.

[0183] It is assumed that the contents of the memory section 24 shown in Figure 23 remains intact in the last-used condition prior to turning off the mobile unit 5-1.

Embodiment 7

[0184] The structure of the mobile unit 5-1 and its operation in Embodiment 7 will be explained in the following.

[0185] Figure 25 shows a block diagram of the configuration of the mobile unit 5-1. The differences of this configuration and that shown in Figure 23 are that a priority table 24d is provided in the memory section 24 and that a priority table generation section 26a, for generating a priority table 24d, is provided on the basis of permissible receiving frequencies 27a residing in ROM 27.

[0186] Figure 26 shows an example of the structure of the table containing the permissible receiving frequencies 27a stored in ROM 27 shown in Figure 25. As shown in this table, permissible receiving frequencies 27a are comprised by two tables. Permissible channel table shown in Figure 26A includes a district name field and a channel number field. The district name is used to distinguish the districts in which the radio server B3.2 and the base station radios 4-2~5 are operating, so that for one radio server B3-2, there is a managing district name. In this example, it is assumed that there are four base station radios 4-2~5 and it is assumed that they are designated by respective district names [a], [b], [c], [d]. Channel numbers define channels that can be used in each district, and in the district [a] for example, channel numbers 1, 2, 3, 4, 5 and 6 are operable.

[0187] Also, the frequency table shown in Figure 26B includes the channel number field and the permissible receiving frequency field. The channel numbers are logical numbers allocated to each permissible receiving frequencies, and it is assumed, in this case, that the mobile unit 5-1 are able to use permissible receiving frequencies f1~f12 corresponding to channel numbers 1~12.

[0188] Figure 27 shows the structure of the priority table 24d stored in the memory section 24. As shown in this diagram, the priority table 24d includes a channel number field, a district name field, a number of districts field, a permissible receiving frequency field. The district names relate to those districts using the frequencies of the assigned channel numbers. For example, in Figure 27, channel number 1 is used in districts a, b, c, so that the number of the districts is three.

[0189] Next, the operation of the mobile unit 5-1 will be explained with reference to the drawings.

[0190] First, when the power is turned on for the mobile unit 5-1, the priority table generation section 26a generates a priority table 24d in the memory section 24 by consulting the permissible receiving frequencies 27a stored in ROM 27. The process of generating the priority table 24d will be explained in the following.

[0191] First, the priority table generation section 26a accesses the permissible receiving frequency table (refer to Figure 26B) of the permissible receiving frequencies 27a stored in ROM 27, and enters the values in the respective fields in the priority table 24d. At this point, the channels numbers and permissible receiving frequencies become listed in respective fields of the priority table 24d, as shown in Figure 28.

[0192] Next, the priority table generation section 26a accesses the permissible frequency table (Figure 26A) of the permissible receiving frequencies 27a stored in ROM 27, and enters the values in the respective fields in the priority table 24d. At this time, the priority table generation section 26a extracts district names using the channel numbers and enters the values in the district name field. In the example shown in Figure 26, channel number [1] is operating in district names [a], [b] and [c], therefore [a], [b], [c] are entered in the district name field corresponding to channel 1 in the priority table 24d.

[0193] By repeating this step, the district names using channel numbers [1]~[12] are entered in the district name field. When the data entry process is completed, the priority table generation section 26a counts the number of districts using each channel number, and the results are entered in the number of district field. At this point, for each channel number, the district names using the channel number and the number of districts using each channel number become listed in the priority table 24d.

[0194] Next, the priority table generation section 26a rearranges the data using the number of districts as the sort key so that the table shows a descending order of channel usage, listing the most frequently used channels at the top, thereby preparing the priority order table 24d shown in Figure 27.

[0195] By following the steps described above, the priority table 24d shown in Figure 27 is prepared from the data in the permissible receiving frequency table and the permissible channel table giving the permissible receiving frequencies 27a shown in Figure 26.

[0196] Next, the operation of the mobile unit 5-1 shown in Figure 25 will be explained with reference to Figure 29. The

difference between the flowcharts shown in Figures 29 and 24 is that the step of selecting a permissible receiving frequency stored in ROM (step S111) is replaced with the step of selecting a permissible receiving frequency in the priority table (step S111b) stored in the memory section.

[0197] In the flowchart shown in Figure 29, steps S101~S110 are the same as the steps S1~S10 in Figure 24, therefore, explanations are omitted.

[0198] In Figure 29, step S101 is executed after the priority table 24d is generated.

[0199] In step S110, when there are no candidates for a down-frequency, the selection section 25 checks from the top data in the priority table 24d stored in memory section 24, through the priority setting action 26, and selects a frequency corresponding to a channel number and assigns this frequency as the receiving frequency (step S111b) and stores the frequency in the memory section 24.

[0200] Next, it is examined whether the signal reception by the demodulator 22 was successful (step S112), and if successful, the received signal is demodulated and is forwarded to the received signal analysis section 23.

[0201] Next, the received signal analysis section 23 analyzes the received signal, and stores down-frequency of the peripheral base station radio in the memory section 24 and obtains up-frequency (step S113) which is forwarded to the judging section 28.

[0202] Next, the judging section 28 reads the permissible sending frequencies 27b stored in ROM 27, and compares it with the up-frequency received from the received signal analysis section 23, and checks whether the up-frequency received is permissible for signal transmission (step S114). This judgment is based on whether the received up-frequency matches the sending frequencies 27b stored in ROM 27. If the result indicates that it can be sent, the judging section 28 stores the up-frequency in the memory section 24. Then, the modulation section 29 uses the sending frequency 24a stored in the memory section 24 to send the registration request from the mobile unit 5-1 (step S105). Also, when there is no need for sending the terminal registration, it is possible to eliminate the step of sending the request.

[0203] Next, if signal reception was not possible in step S112 or if the up-frequency is not the permissible frequency in step S114, steps S111~S114 are repeated (step S115). Next, in step S115, if there are no other permissible receiving frequencies, the mobile unit 5-1 is not able to use the present managing district so that it is necessary to move to another managing district, and attempt the steps shown in Figure 24.

[0204] In Figure 29, steps S101~104 and S106~S111 may be skipped, and after preparing the priority table 24d, step S111b may be executed immediately afterward.

[0205] As described above, because the mobile radio has information regarding the operational frequencies from the base station radios, if signal reception becomes difficult, information on the operational frequencies can be used to switch to another operational frequency. Switching the operational frequency provides an advantage that, because there is no change in the managing server for the mobile device, the connection can be maintained without having to go through the registration and approval processes even when communicating with other base station radios.

[0206] Also, use of the priority table indicating the most popular receiving frequencies provides an advantage that a selection of receiving frequency is facilitated and the system operates at an optimum efficiency.

[0207] Also, chronological switching of operational frequency provides an advantage that redundant terminal registration can be avoided and the use of unauthorized up-frequencies can be avoided because only the permissible up-frequencies are accepted. Because the permissible frequencies and the operational frequencies of the station devices are stored in the mobile device in the order of popularity, the probability of accessing an operational frequency and the process of selecting an operational frequency are improved significantly.

[0208] It is assumed that the operating channels had already been input in ROM when the mobile unit 5-1 is activated.

[0209] The programs shown in Figures 24, 29 may be recorded on a computer-readable recording media such as floppy discs, CD-ROM, opto-magnetic discs, IC cards, DVD-ROM, so that computer means can execute application programs to select an operational frequency.

[0210] The application programs are totally or partially recorded on portable memory media such as floppy discs and CD-ROM; and fixed memory devices such as hard discs. Application program may perform a part of the described functions, or may be operated in conjunction with pre-recorded programs stored in computer systems.

[0211] Computer-readable recording media include not only static memories, such as opto-magnetic discs, but short-term dynamic memories used in transmitting programs and data through communication circuits such as Internet or telephone circuits, as well as other short-term memories such as volatile memories used in servers and client computer systems.

[0212] In other words, a computer-readable recording medium containing a frequency selection program for a wireless mobile unit should include processing steps of: receiving a first up-frequency given by the base station radio using a last receiving frequency of the mobile radio; judging whether or not the first up-frequency is a permissible sending frequency for the mobile radio, so that, if the up-frequency is permissible, sending a terminal registration request to the base station radio using the up-frequency; however, if the last frequency is not useable, receiving a second up-frequency from a peripheral base station radio using a down-frequency allocated to the peripheral base station radio, judging whether or not the second up-frequency is a permissible sending frequency; and if the second up-frequency is

permissible, sending the terminal registration request to the peripheral base station radio using the second up-frequency; however, if the last receiving frequency and the second down-frequency of the peripheral base station radio cannot be used by the mobile radio, then, searching in a memory section of the mobile radio for a permissible receiving frequency, by successively testing permissible receiving frequencies until a permissible receiving frequency that can be used by the mobile radio is found; receiving a third up-frequency from a base station radio that sent the third up-frequency using the permissible receiving frequency; judging whether or not the third up-frequency is a permissible sending frequency, and if it is permissible, sending the terminal registration to the base station radio that sent the third up-frequency.

[0213] Also, if the last-used receiving frequency and any of the down-frequencies of the peripheral stations cannot be used by the mobile radio, then, the subsequent steps presented above may be replaced with the following steps: searching for a receiving frequency that can be used by the mobile radio, by successively testing permissible receiving frequencies so as to find a station device whose down-frequency matches a permissible receiving frequency for the mobile radio, beginning with a down-frequency shared by the highest number of station devices until a receiving frequency that can be used by the mobile radio is found; receiving a third up-frequency from a station device using the receiving frequency; checking whether or not the third up-frequency received is a permissible sending frequency; and if it is permissible, sending the terminal registration to the base station radio that sent the third up-frequency.

[0214] Further, the above program may directly proceed to the step of: searching for a receiving frequency that can be used by the mobile radio, by successively testing permissible receiving frequencies so as to find a base station radio whose down-frequency matches a permissible receiving frequency for the mobile radio, beginning with a down-frequency shared by the highest number of base station radios until a receiving frequency that can be used by the mobile radio is found; receiving an up-frequency from a base station radio using the receiving frequency; checking whether or not the up-frequency received is a permissible sending frequency; and if it is permissible, sending the terminal registration to the base station radio that sent the up-frequency.

FIGURES

[0215]

Figure 1

host server 1; radio server A; base station radio 4-1; mobile radio 5a; terminal device 5b; mobile unit 5-1

Figure 2

Internet; host server, sub-net A; radio server A; terminal device
(c) packet
Dst: terminal
Src: host
data
(d) packet
Dst: server B
Src: server A
Dst: terminal
Src: host
data
(e) packet
Dst: mobile device
Src: server B
(m) packet not (l) packet because it looks like one

Figure 3

radio server A
start
S4: receive terminal registration completion notice
S6: stop terminal managing
end
radio server B

start
S1: receive terminal registration request
S2: perform registration steps
S3: send registration completion notice
end
radio server C
start
S5: receive registration completion notice
S7: renew managing information
end
host server

Figure 4

radio server A
start
S12: receive IP packet
S13: route to server B
end
radio server B
start
S14: receive IP packet
S15: route to terminal device
end
host server
start
S11: receive IP packet
end

Figure 5

radio server B
start
S21: receive IP packet
S22: send packet to host server
end
host server
start
S23: receive IP packet
S24: identify change in sub-net for terminal device
end

Figure 6

radio server B
start
S32: receive IP packet
S33: route to terminal device
end

Figure 7

base station radio 4-5
mobile unit 5-1

Figure 8

database 7-2;

base station radio 4-7

Figure 9

(a) request terminal registration
(b) approval request
(c) approval request
(d) approval response
(g) registration accept/deny
(f) match

Figure 10

network connection section 3a; relay agent section 3b; terminal connection section 3c; home server defining section 3d

Figure 11

start
S41: receive IP address request from terminal device
S42: deduce home server for terminal device
S43: send IP address request to home server on behalf of terminal device
S44: receive IP address issued by home server
S45: distribute IP address received to terminal device

Figure 12

isdn router

Figure 13

broadcast terminal device
base station radio 4-2
mobile unit 5-1

Figure 14

broadcast level defining section 3i; broadcast information receiving section 3e; broadcast information reconstruction section 3f; channel selection section 3j; sending section 3h

Figure 15

broadcast information extraction section 5b; display section 5c

Figure 16

S46: receive broadcast information
S47: reconstruct information by grouping and consulting broadcast levels
S48: select channel for receiving device
S49: send grouped broadcast information

Figure 17

S52: extract only required information for a given level
S53: display extracted information

Figure 18

OCID: <EP 0987860A2 I >

header section; information 1
broadcast level number bit 0
(lowest bit)
information 2
broadcast level number bit 1
information 4
broadcast level number 3
highest bit

Figure 19

terminal registration information
terminal information memory section 3n; multi-cast information receiving section 3j; destination deciding section 3k; sending section 3m

Figure 20

S61: receive multi-cast information
S62: decide destinations by consulting terminal information memory section
S63: distribute multi-cast information to respective terminal devices

Figure 22

radio server B
server data receiving section 11; memory section 12; peripheral station down-frequency 12a; own station up-frequency 12b; own station down-frequency 12c; ROM 13; receivable frequencies (up-frequency) 13a; receivable frequencies (down-frequency) 13b; judging section 14, 15; sending data preparation section 16; modulation section 17; signal sending section 18

Figure 23

judging section 28; ROM 27; permissible receiving frequencies 27a; permissible sending frequencies 27b; selection section 25; priority setting section 26; memory section 24; sending frequencies 24a; receiving frequencies 24b; peripheral station down-frequencies 24c; modulation section 29; demodulation section 22; received signal analysis section 23; signal sending section 30; signal receiving section 21

Figure 24

start
S101: select last-used frequency for station
S102: signal reception successful?
S103: obtain up-frequency
S104: up-frequency a permissible sending frequency?
S105: send terminal registration request
S106: select peripheral station frequency
S107: signal reception successful?
S108: obtain up-frequency
S109: up-frequency a permissible sending frequency?
S110: next candidate?
S111: select permissible receiving frequency in ROM
S112: signal reception successful?
S113: obtain up-frequency
S114: up-frequency a permissible sending frequency?
S115: next candidate?
End

Figure 25

memory 24; priority table 24d; priority table preparation section 26a

Figure 26

district name	useable channel number	channel number	permissible frequency
a	1, 2, etc	1	f1

Figure 27

channel number: operating district names: number of districts: permissible receiving frequency

Figure 29

start
S101: select last-used frequency for station
S102: signal reception successful?
S103: obtain up-frequency
S104: up-frequency a permissible sending frequency?
S105: send terminal registration request
S106: select peripheral station frequency
S107: signal reception successful?
S108: obtain up-frequency
S109: up-frequency a permissible sending frequency?
S110: next candidate?
S111: select permissible receiving frequency in priority table in memory section
S112: signal reception successful?
S113: obtain up-frequency
S114: up-frequency a permissible sending frequency?
S115: next candidate?

Claims

1. A radio server system, for wirelessly connecting a mobile unit (5-1) having a terminal device (5b) and a mobile radio (5a) to Internet, comprising:

   not less than one radio server (3-1) for communicating with Internet; and
   a plurality of base station radios (4-1) connected to said radio server for wireless communication with said mobile unit by way of said mobile radio; wherein
   one radio server within a district of communication range of said base station radios is designated as a home server for said mobile radio, and said terminal device communicates with Internet by way of said mobile radio.

2. A radio server system according to claim 1, wherein said radio server (3-1) is comprised by:

   a terminal approval managing section for allowing a mobile radio to be connected to a radio server, by approving said mobile radio in response to a terminal registration request sent from said mobile radio;
   a terminal managing section for issuing to said mobile radio an IP address available for use at a time of connecting said mobile device to said radio server, and registering a connection of said mobile device.

3. A radio server system according to claim 2, wherein said system, in response to a terminal registration request from a mobile device for a connection to a radio server that is not its home server, sends a request by way of Internet to said home server for said mobile radio of said mobile unit to issue a terminal approval and an IP address, and, when an approval and an address are issued by said home server, approves a connection of said mobile unit to said radio server.

4. A radio server system according to claim 3, wherein said system is further comprised by a packet routing section, which is used when a presently communicating radio server for a mobile unit is not its home server and when packet data addressed to said mobile unit arrive at a previously-connected radio server, said packet routing section transfers said packet data to said presently communicating radio server according to an IP address obtained from said home server.

5. A radio server system according to claim 4, wherein when a presently communicating radio server is not its home server for a mobile unit, and packet data addressed to said mobile unit are transferred to said mobile unit, a host server on the Internet that routed the packet data is advised of the identity of said presently communicating radio server so that subsequent packet data are routed directly to said presently communicating radio server without being sent to a previously-connected radio server.

6. A radio server system according to claim 1, wherein a radio server (3-1) is provided with:

a broadcast information receiving section (3e) for receiving information broadcast by way of a network connected to said radio server;
a broadcast level defining section (3i) having assigned broadcast levels for a plurality of mobile units for communication with said radio server connected to said network; and
a broadcast information reconstruction section (3f) for reconstructing received information according to each broadcast level; wherein
said radio server distributes reconstructed information prepared by said broadcast information reconstruction section to said plurality of mobile units.

7. A radio server system according to claim 1, wherein a radio server (3-1) is provided with:

a multi-cast information receiving section (3j) for receiving multi-cast information by way of a network connected to said radio server;
a terminal information memory section (3n) having classifications for distributing multi-cast information to defined groups of mobile units; and
a destination deciding section (3k) for determining destinations for distributing multi-cast information according to said classifications.

8. A radio server system according to claim 1, wherein, a radio server (3-1) is provided with a relay agent section (3b) so that, when it is necessary for a mobile unit presently communicating with said radio server to receive an IP address from another radio server, said relay agent section sends an IP address request made by said mobile unit to said another network, and receives a reply packet from said another network on behalf of said mobile unit.

9. A radio server system according to claim 1, wherein a wireless station (4-1) device is provided with an IP address containing a same network address as a radio server to which said base station radio is connected so as to enable communication between said radio server and said base station radio using Internet protocol.

10. A radio server system according to claim 1, wherein a wireless station (4-1) device is provided with:

a memory section (12) for receiving and storing up-frequencies and down-frequencies of said base station radio and down-frequencies of a peripheral base station radio received from an external source;
a read-only-memory section (13) for storing operational frequencies for sending and receiving data by said base station radio; and
a judging section (14, 15) for comparing up-frequencies and down-frequencies of said base station radio stored in said memory section and operational frequencies stored in said read-only-memory section, so as to determine whether or not an operational frequency received from an external source is useable; wherein
when said judging section determines that said operational frequency is useable, said base station radio sends an up-frequency of said base station radio and a down-frequency of said peripheral base station radio using a down-frequency of said base station radio.

11. A mobile radio (5a), connected to a terminal device (5b) of a mobile unit (5-1), for wirelessly connecting said terminal device to Internet by way of a base station radio, comprising

a memory section (24) for storing a last operational frequency used by said mobile radio and down-frequencies

of a peripheral base station radio;
a read-only-memory section (27) for storing permissible operational frequencies for sending and receiving data through said mobile radio; and
a judging section (28) for comparing frequencies stored in said memory section and permissible operational frequencies stored in said read-only-memory section, and judging whether or not an operational frequency to be used by said mobile radio is useable; wherein
up-frequencies transmitted from said base station radio are tested by using successively said last receiving frequency, said down-frequencies of said peripheral base station radio and said permissible receiving frequencies so that a terminal registration request is transmitted only when an up-frequency received matches with a receiving frequency permitted for said mobile radio.

12. A mobile radio according to claim 11, wherein said mobile radio (5a) is further provided with a priority table generation section (26a) in a memory section for generating a priority table for efficiently selecting a receiving frequency from permissible receiving frequencies for said mobile radio, wherein a receiving frequency that can be used as an up-frequency to send said terminal registration request can be selected from said permissible receiving frequencies with reference to said priority table.

13. A mobile radio (5a), connected to a terminal device (5b) of a mobile unit (5-1), for wirelessly connecting said terminal device to Internet by way of a base station radio (4-1), comprising:

a read-only-memory (27) for storing a plurality of permissible receiving frequencies and permissible sending frequencies
a priority table generation section (26a) in a memory section for generating a priority table for efficiently selecting a receiving frequency from said permissible receiving frequencies;
a judging section (28) for comparing operational frequencies of said mobile radio and operational frequencies stored in said read-only-memory section, and judging whether or not a frequency to be used by said mobile radio is useable; wherein a receiving frequency for receiving an up-frequency that can be used by said mobile radio to send said terminal registration to said base station radio is selected from said permissible receiving frequencies by consulting said priority table and successively testing receiving frequencies so as to receive an up-frequency sent from said base station radio, and only when said up-frequency is a receiving frequency permitted for said wireless mobile unit, a terminal registration is transmitted.

14. A mobile radio according to claim 13, wherein said priority table (24d) is arranged in an order of the highest number of base station radios using same channels operating on same frequencies as permissible receiving frequencies of said mobile radio, according to a useable channel table defining useable channels for each base station radio and a frequency table relating said useable channels to permissible receiving frequencies.

15. A method for wireless communication by performing a relay agent process in response to an IP address request for the radio server system disclosed in claim 1, comprising the steps of:

receiving an IP address request sent from said mobile radio (step S41);
deducing a home server for said mobile radio according to contents of said IP address request (step S42);
transmitting said IP address to said home server on behalf of said mobile radio (step S43);
receiving an IP address issued by said home server (step S44); and
distributing said IP address to said mobile radio (step S45).

16. A method of providing wireless communication between a base station radio and a mobile radio, comprising the steps of:

receiving a first up-frequency given by said base station radio using a last receiving frequency of the mobile radio;
judging whether or not said first up-frequency is a permissible sending frequency for said mobile radio, so that, if said up-frequency is permissible; sending a terminal registration request to said base station radio using said first up-frequency; however, if the last frequency is not useable (step S101, S102, S103, S104, S105),
receiving a second up-frequency from a peripheral base station radio using a down-frequency allocated to said peripheral base station radio,
judging whether or not said second up-frequency is a permissible sending frequency; and if said second up-frequency is permissible, sending the terminal registration request to said peripheral base station radio using

said second up-frequency; however, if said last receiving frequency and said second down-frequency of said peripheral base station radio cannot be used by said mobile radio (step S106, S107, S108, S109, S105) , then, searching in a memory section of said mobile radio for a permissible receiving frequency for said mobile radio, by successively testing permissible receiving frequencies until a permissible receiving frequency that can be used by said mobile radio is found; receiving a third up-frequency from a base station radio that sent the third up-frequency using said permissible receiving frequency; judging whether or not said third up-frequency is a permissible sending frequency, and if it is permissible, sending the terminal registration to said base station radio that sent the third up-frequency (step S111, S112, S113, S114, S105).

17. A method of providing wireless communication between a base station radio and a mobile radio, comprising the steps of:

receiving a first up-frequency given by said base station radio using a last receiving frequency of the mobile radio;
judging whether or not said first up-frequency is a permissible sending frequency for said mobile radio, so that, if said up-frequency is permissible; sending a terminal registration request to said base station radio using said first up-frequency; however, if said last frequency is not useable (step S101, S102, S103, S104, S105),
receiving a second up-frequency from a peripheral base station radio using a down-frequency allocated to said peripheral base station radio,
judging whether or not said second up-frequency is a permissible sending frequency; and if said second up-frequency is permissible, sending the terminal registration request to said peripheral base station radio using said second up-frequency; however, if said last receiving frequency and said second down-frequency of said peripheral base station radio cannot be used by said mobile radio (step S106, S107, S108, S109, S105), then, searching for a receiving frequency that can be used by said mobile radio, by successively testing permissible receiving frequencies so as to find a base station radio whose down-frequency matches a permissible receiving frequency for said mobile radio, beginning with a down-frequency shared by the highest number of base station radios until a receiving frequency that can be used by said mobile radio is found; receiving a third up-frequency from a station device using said receiving frequency; checking whether or not the third up-frequency received is a permissible sending frequency; and if it is permissible, sending the terminal registration to the base station radio that sent said third up-frequency (step S111b, S112, S113, S114, S105).

18. A method for providing communication between a base station radio and a mobile radio, comprising the steps of:

searching for a receiving frequency that can be used by said mobile radio, by successively testing permissible receiving frequencies so as to find a base station radio whose down-frequency matches a permissible receiving frequency for said mobile radio, beginning with a down-frequency shared by the highest number of base station radios until a receiving frequency that can be used by the mobile radio is found; receiving an up-frequency from a base station radio using said receiving frequency; checking whether or not said up-frequency received is a permissible sending frequency; and if it is permissible, sending the terminal registration to said base station radio that sent said up-frequency (step S111b, S112, S113, S114, S105).

19. A terminal connection program, loadable into a computer, for providing a mobile unit connecting process for the radio server disclosed in claim 2, said terminal connection program effecting the steps of:

approving a mobile radio in response to a terminal connection request from said mobile radio;
issuing an IP address presently available for use in response to an IP address request from said mobile radio;

20. A distribution program, loadable into a computer, for broadcasting information divided into a classification of level groups for the radio server disclosed in claim 6, said distribution program effecting the steps of:

receiving information broadcast to a network connected to a radio server (step S46);
reconstructing broadcast information received by consulting a broadcast level defining section having defined broadcast levels (step S47); and
distributing reconstructed broadcast information to a terminal device connected to said radio server (step S49).

21. A distribution program, loadable into a computer, for multi-casting information for the radio server disclosed in claim 7, said distribution program effecting the steps of:

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receiving multi-cast information (step S61);
deciding distribution destinations of said multi-cast information, by consulting terminal information (step S62); and
distributing said multi-cast information according to distribution destinations thus determined (step S63).

22. A relay agent program, loadable into a computer, for processing an IP address request for the radio server disclosed in claim 8, said relay agent program effecting the steps of:

processing an IP address request from said mobile radio (step S41);
deducing a home server of the said mobile radio according to contents of said IP address request (step S42);
issuing an IP address request to said home server on behalf of said mobile radio (step S43);
receiving an IP address issued by said home server (step S44); and
distributing said IP address received to said mobile radio (step S45).

23. An operational frequency selection program, loadable into a computer, for a mobile radio disclosed in claim 11, said operational frequency selection program effecting the steps of:

receiving a first up-frequency given by said base station radio using a last receiving frequency of said mobile radio;
judging whether or not said first up-frequency is a permissible sending frequency for said mobile radio, so that, if said up-frequency is permissible; sending a terminal registration request to said base station radio using the first up-frequency; however, if said last frequency is not useable (step S101, S102, S103, S104, S105),
receiving a second up-frequency from a peripheral base station radio using a down-frequency allocated to said peripheral base station radio,
judging whether or not said second up-frequency is a permissible sending frequency, so that if said second up-frequency is permissible, sending the terminal registration request to said peripheral base station radio using said second up-frequency;
however, if said last receiving frequency and said second down-frequency of said peripheral base station radio cannot be used by said mobile radio (step S106, S107, S108, S109, S105), then,
searching in a memory section of said mobile radio for a permissible receiving frequency, by successively testing permissible receiving frequencies until a permissible receiving frequency that can be used by said mobile radio is found; receiving a third up-frequency from a base station radio that sent the third up-frequency using said permissible receiving frequency; judging whether or not the third up-frequency is a permissible sending frequency, and if it is permissible, sending the terminal registration to said base station radio that sent the third up-frequency (step S111, S112, S113, S114, S105).

24. An operational frequency selection program, loadable into a computer, for a mobile radio disclosed in claim 12, said operational frequency selection program effecting the steps of:

receiving a first up-frequency given by said base station radio using a last receiving frequency of the mobile radio;
judging whether or not said first up-frequency is a permissible sending frequency for said mobile radio, so that, if said first up-frequency is permissible; sending a terminal registration request to said base station radio using the first up-frequency; however, if the last-used frequency is not useable (step S101, S102, S103, S104, S105),
receiving a second up-frequency from a peripheral base station radio using a down-frequency allocated to said peripheral base station radio,
judging whether or not said second up-frequency is a permissible sending frequency; and if said second up-frequency is permissible, sending the terminal registration request to said peripheral base station radio using said second up-frequency; however, if said last receiving frequency and said second down-frequency of said peripheral base station radio cannot be used by said mobile radio (step S106, S107, S108, S109, S105), then,
searching for a receiving frequency that can be used by said mobile radio, by successively testing permissible receiving frequencies so as to find a base station radio whose down-frequency matches a permissible receiving frequency for said mobile radio, beginning with a down-frequency shared by the highest number of base station radios until a receiving frequency that can be used by said mobile radio is found; receiving a third up-frequency from a station device using said receiving frequency; checking whether or not the third up-frequency received is a permissible sending frequency; and if it is permissible, sending the terminal registration to the base station radio that sent said third up-frequency (step S111b, S112, S113, S114, S105).

25. An operational frequency selection program, loadable into a computer, for the mobile radio disclosed in claim 13, operational frequency selection program effecting the steps of:

searching for a receiving frequency that can be used by said mobile radio, by successively testing permissible receiving frequencies so as to find a base station radio whose down-frequency matches a permissible receiving frequency for said mobile radio, beginning with a down-frequency shared by the highest number of base station radios until a receiving frequency that can be used by the mobile radio is found; receiving an up-frequency from a base station radio using said receiving frequency; checking whether or not said up-frequency received is a permissible sending frequency; and if it is permissible, sending the terminal registration to the base station radio that sent said up-frequency (step S111b, S112, S113, S114, S105).

FIG. 1

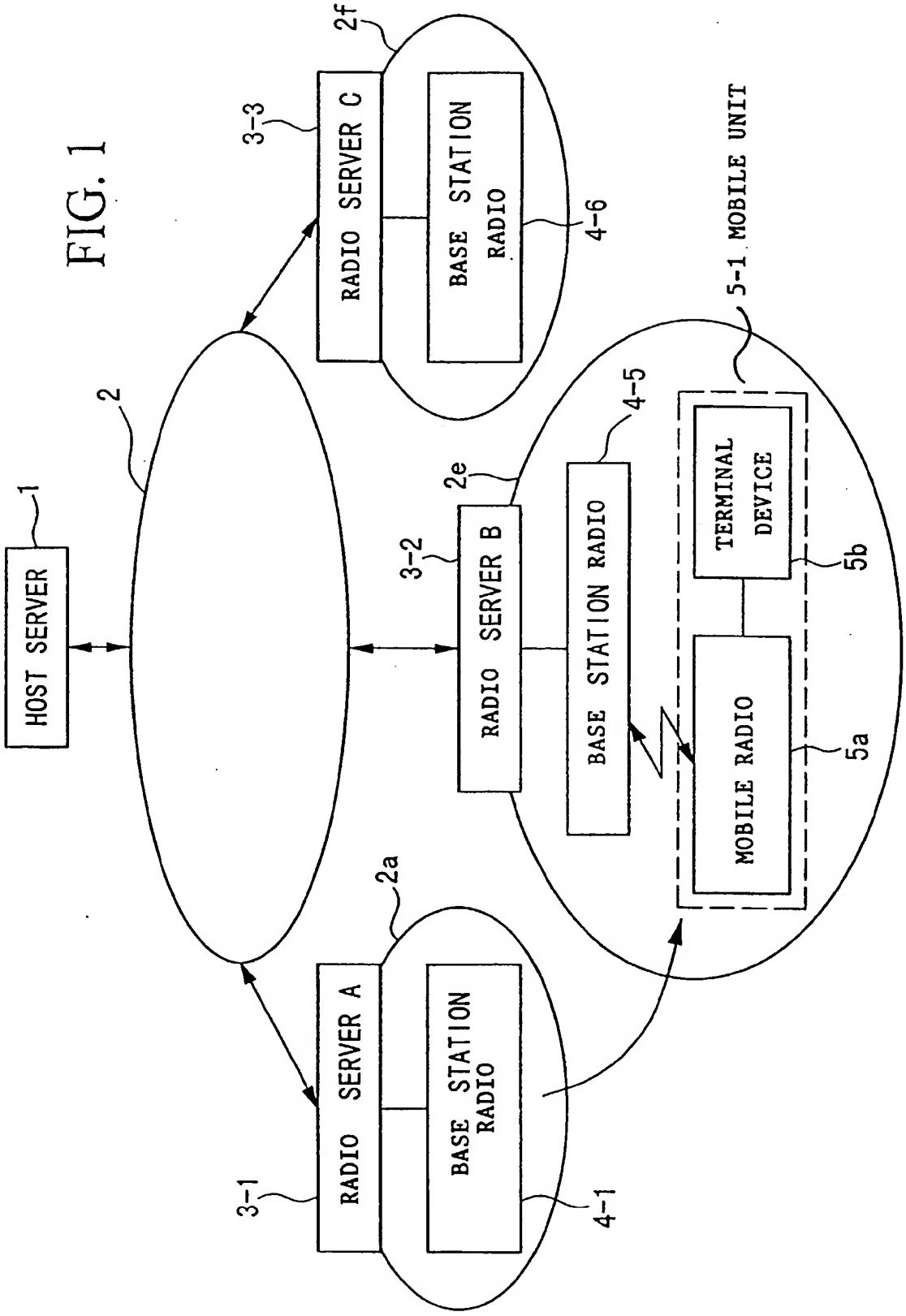


FIG. 2

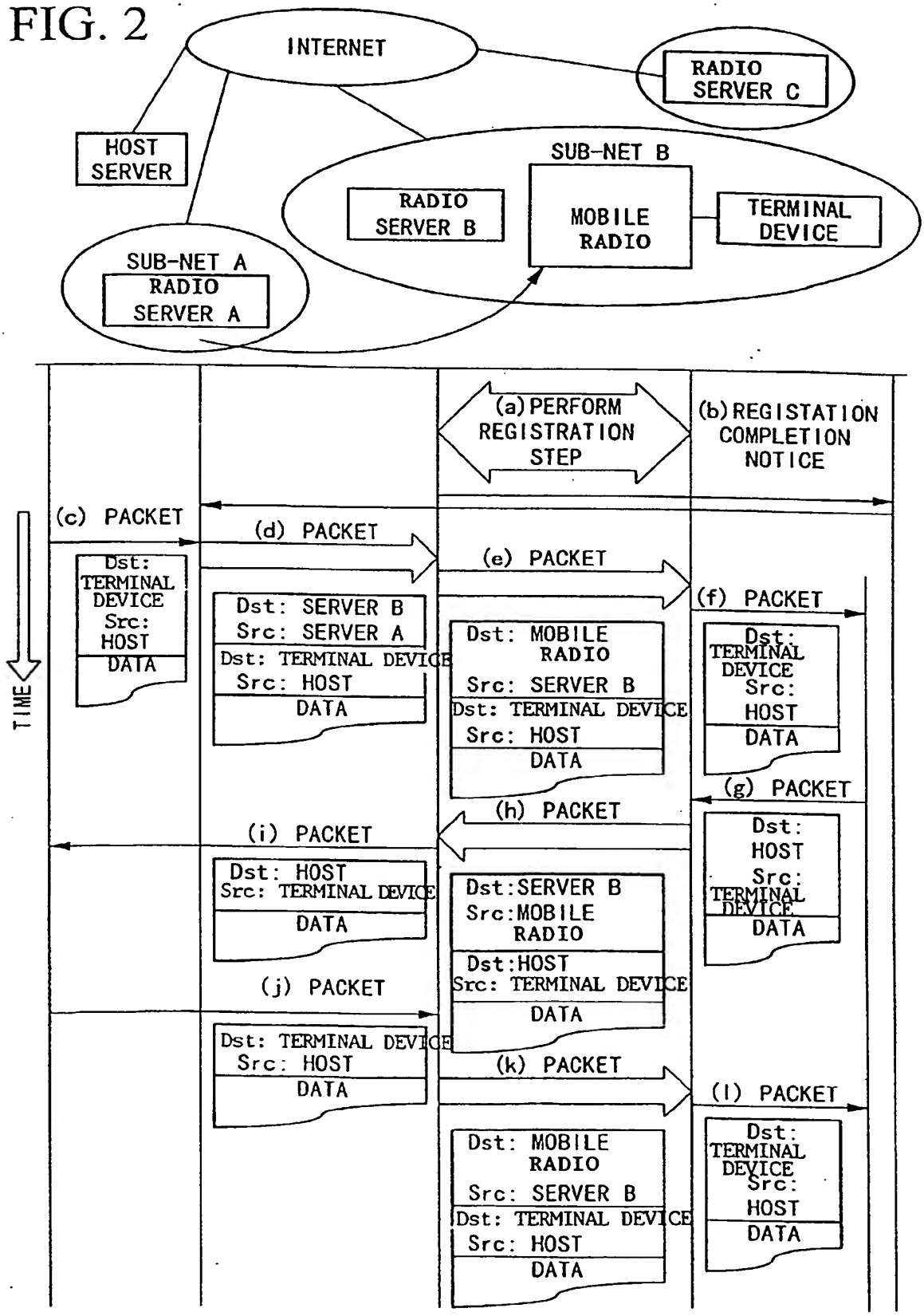


FIG. 3

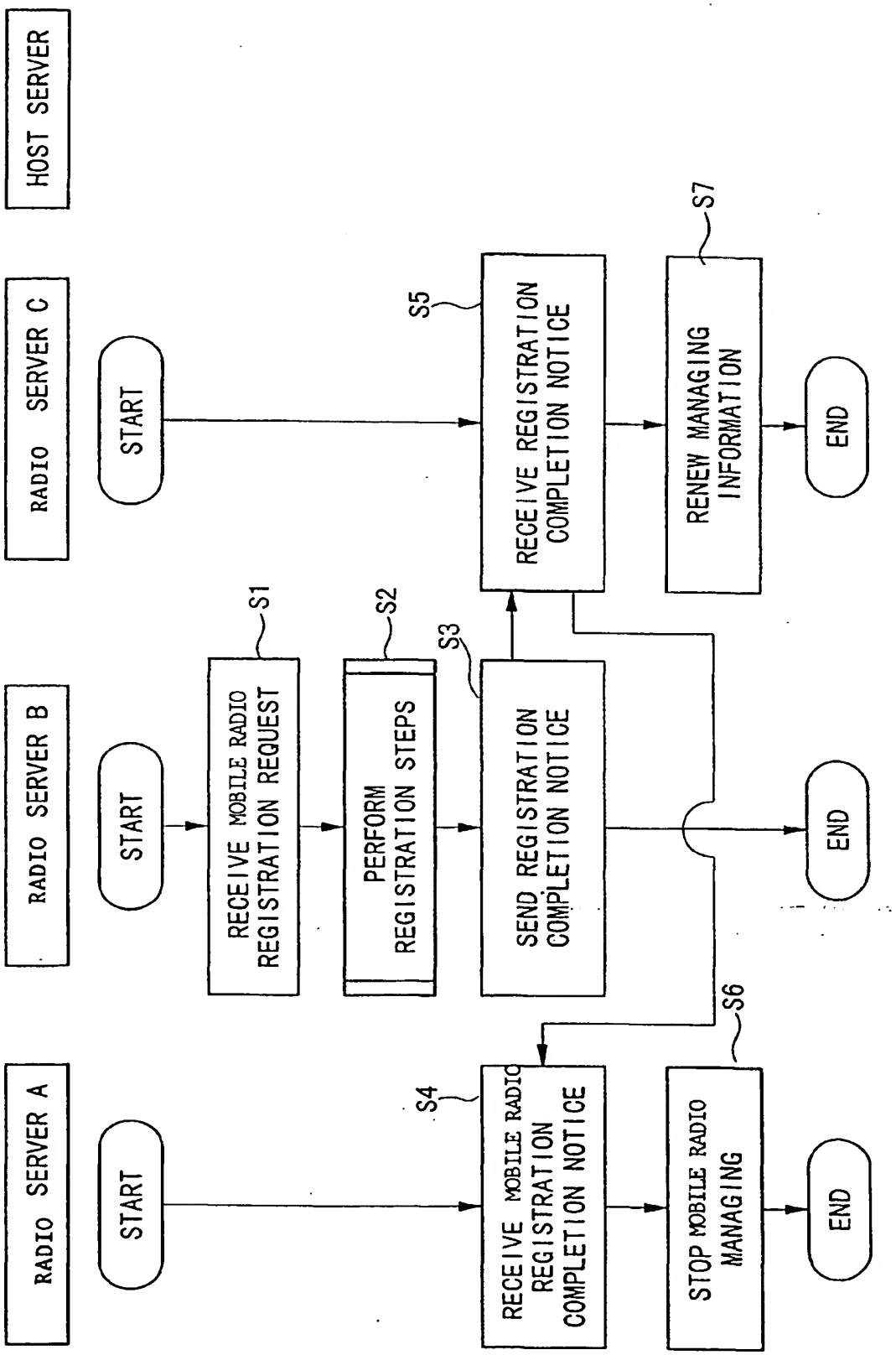


FIG. 4

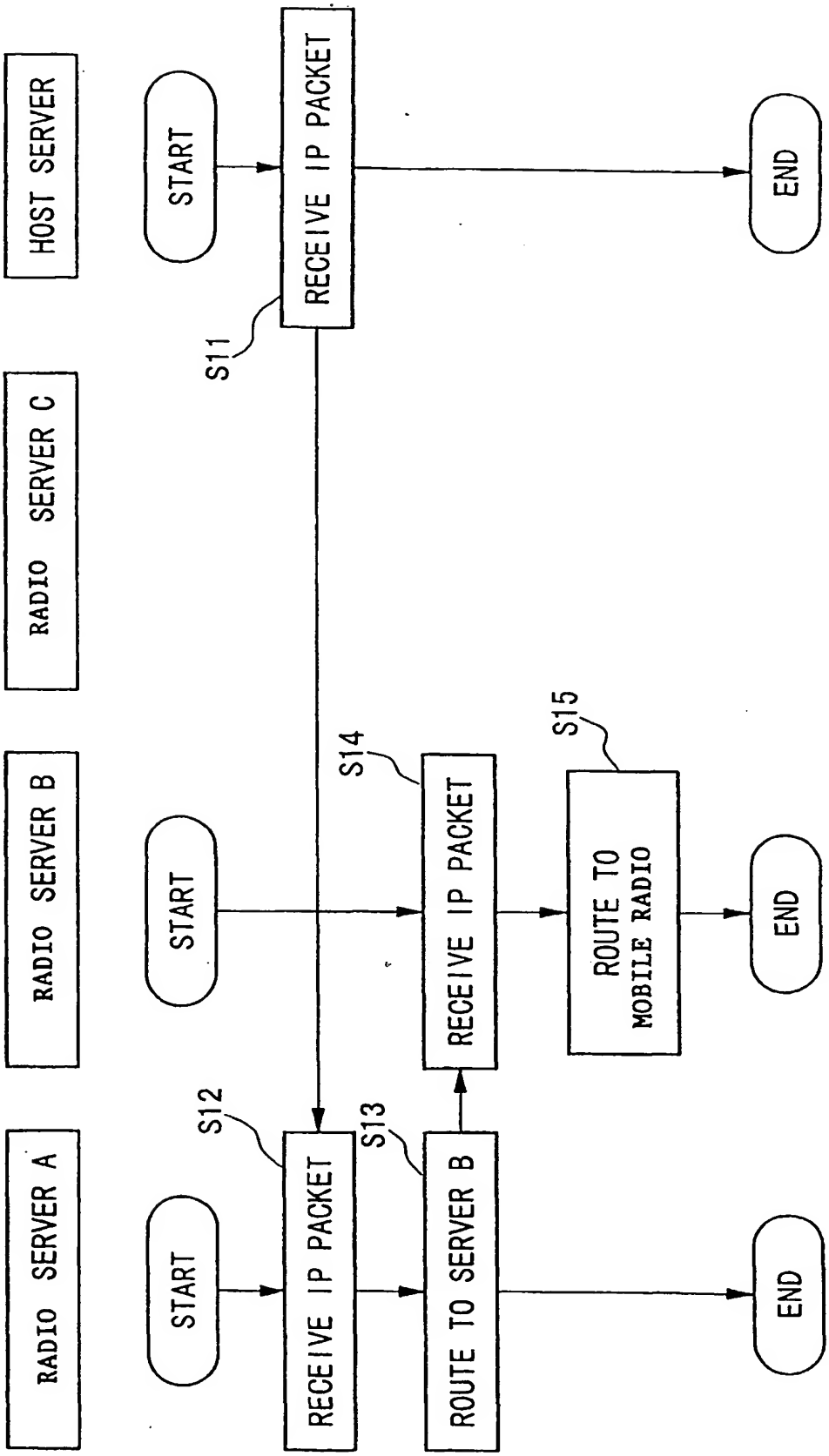

HOST SERVER
RADIO SERVER C
RADIO SERVER B
RADIO SERVER A
START
RECEIVE IP PACKET
END
S11
START
RECEIVE IP PACKET
ROUTE TO MOBILE RADIO
END
S14
S15
START
RECEIVE IP PACKET
ROUTE TO SERVER B
END
S12
S13

FIG. 5

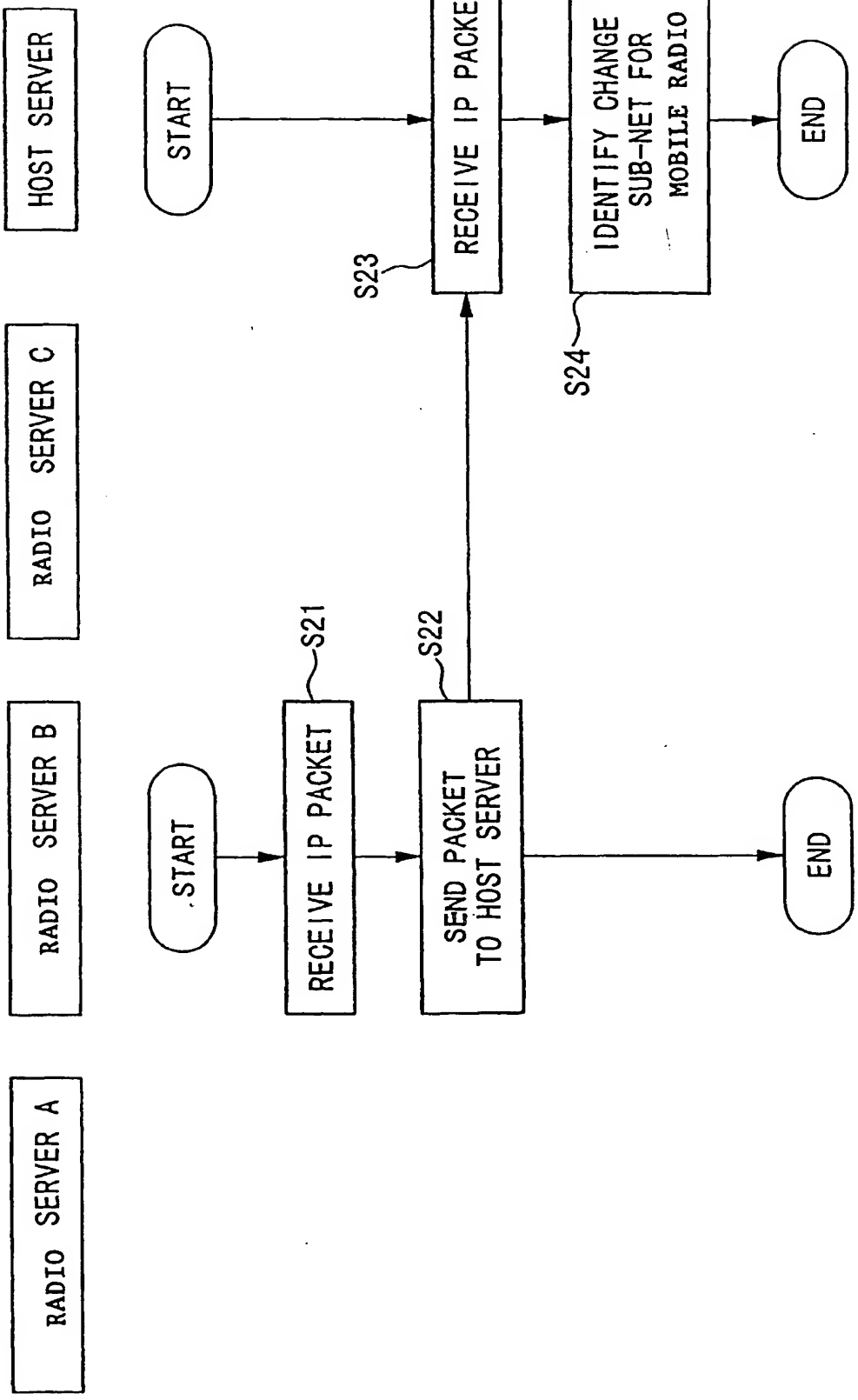


FIG. 6

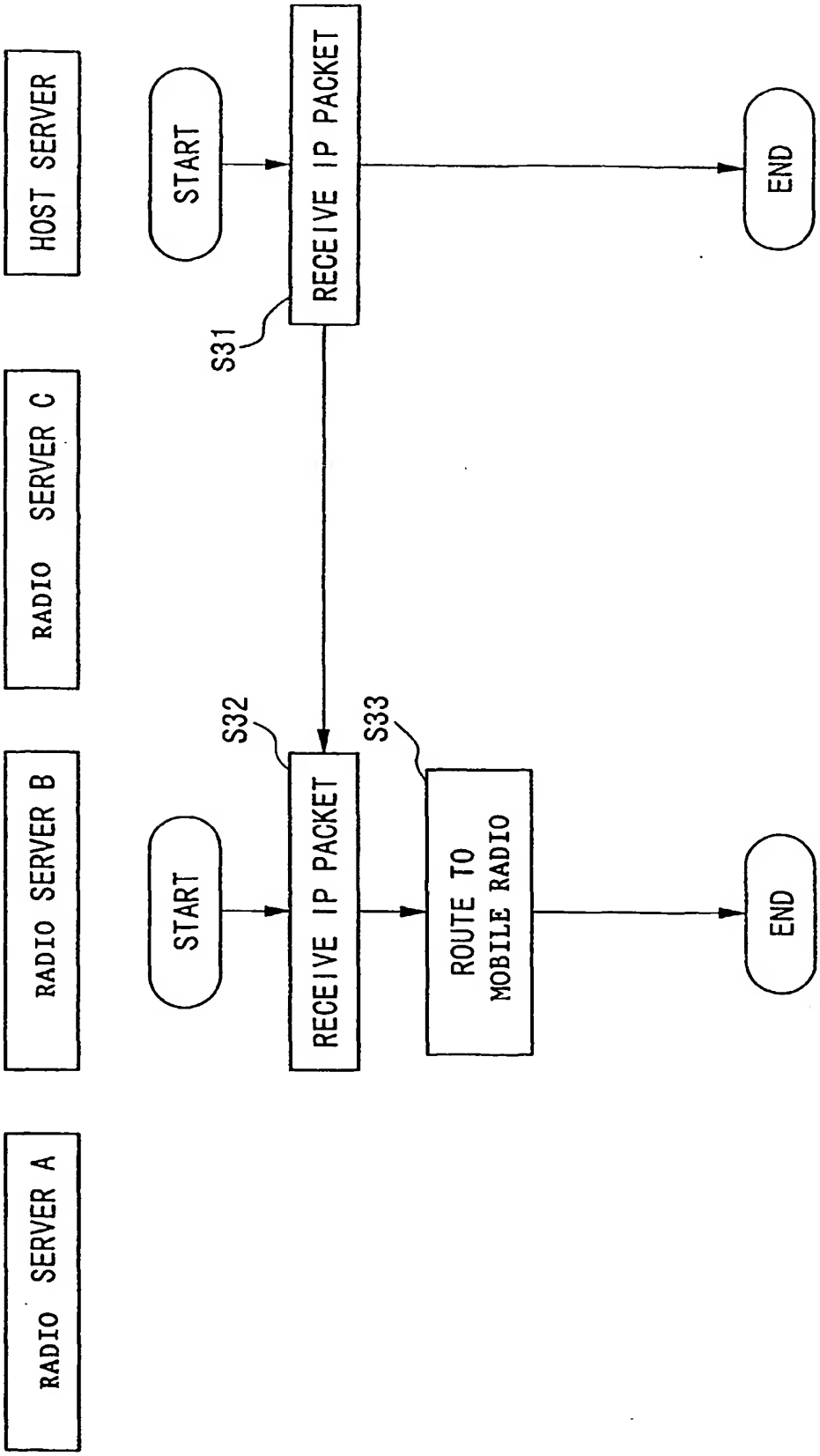


FIG. 7

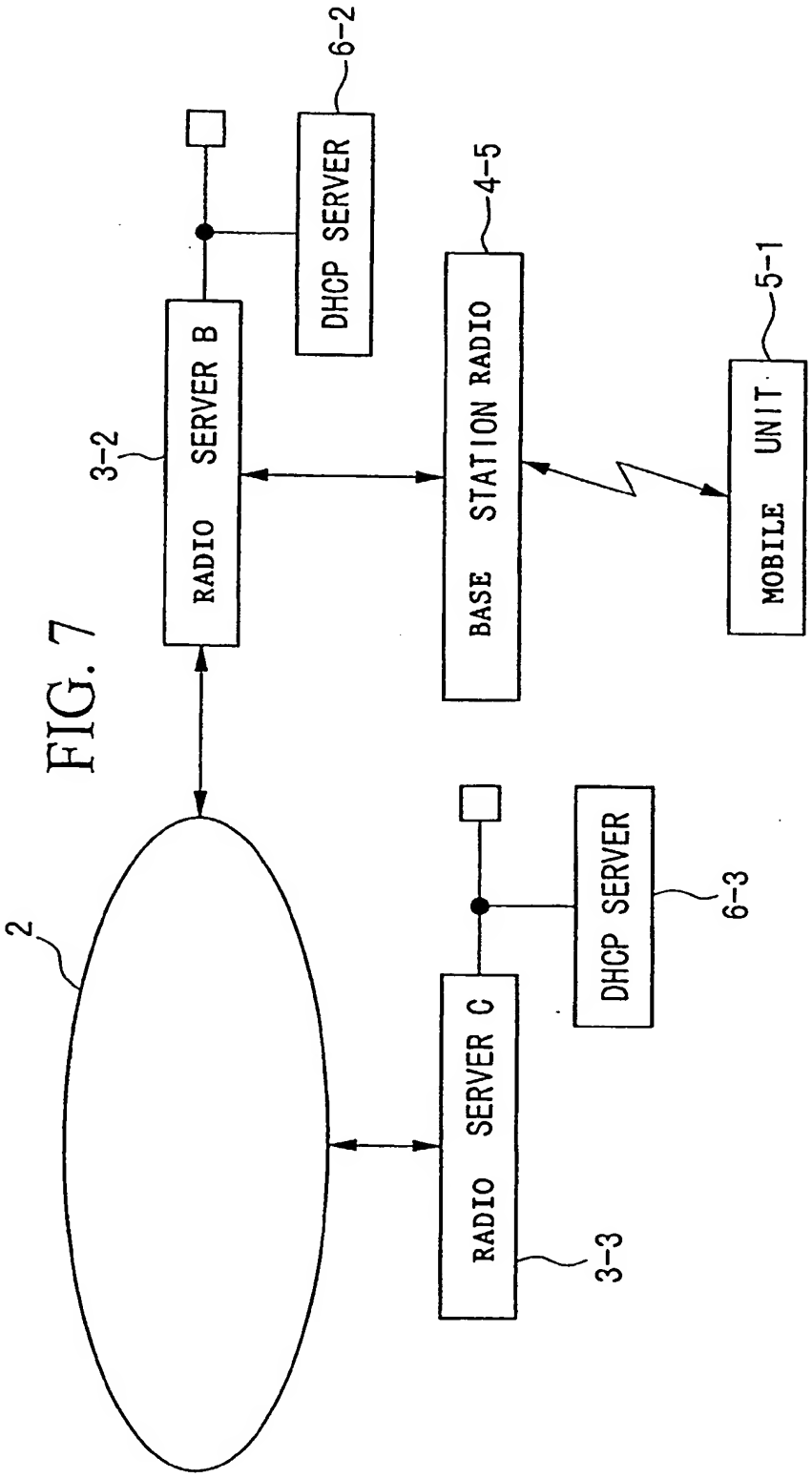


FIG. 8

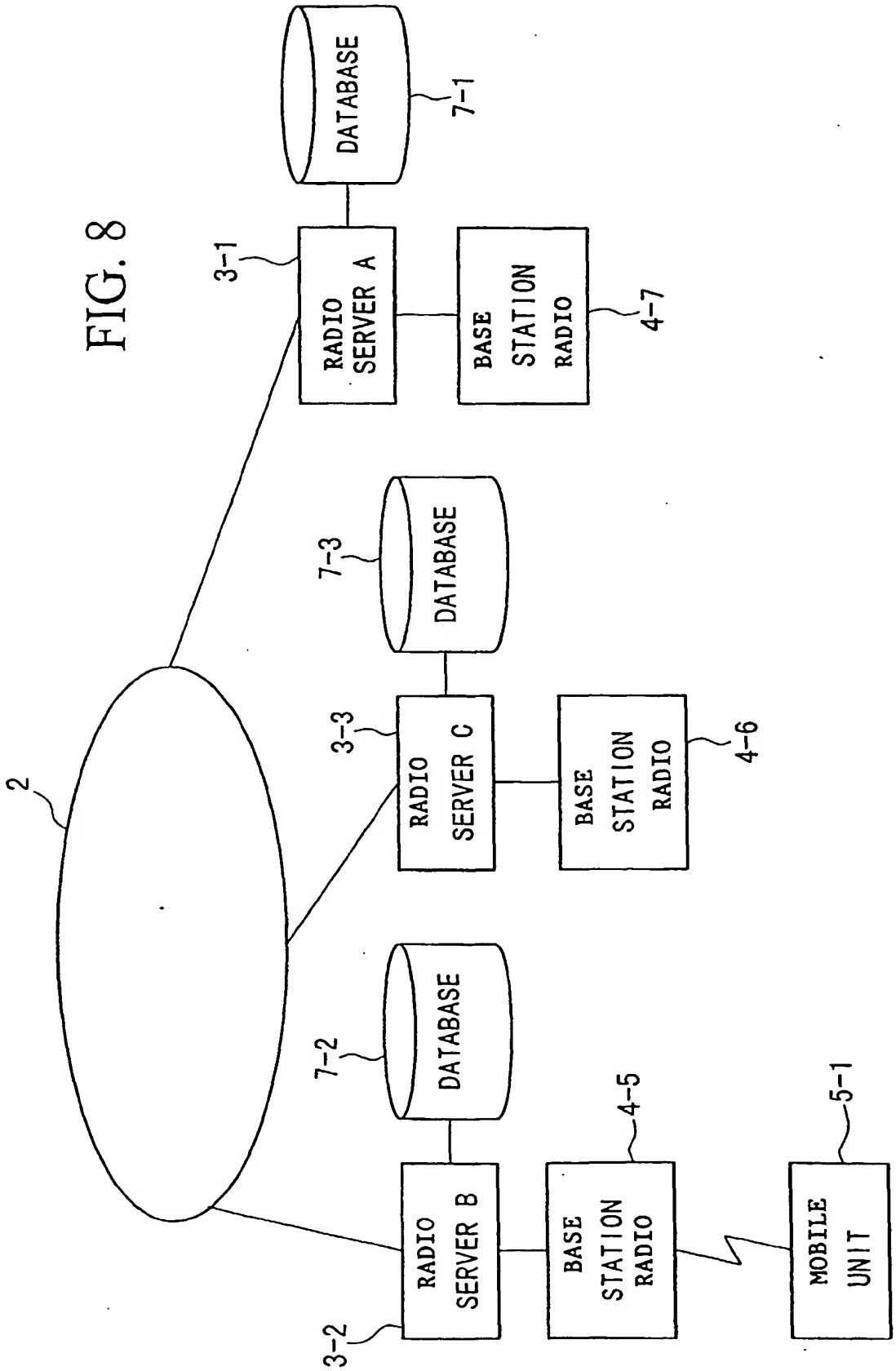


FIG. 9

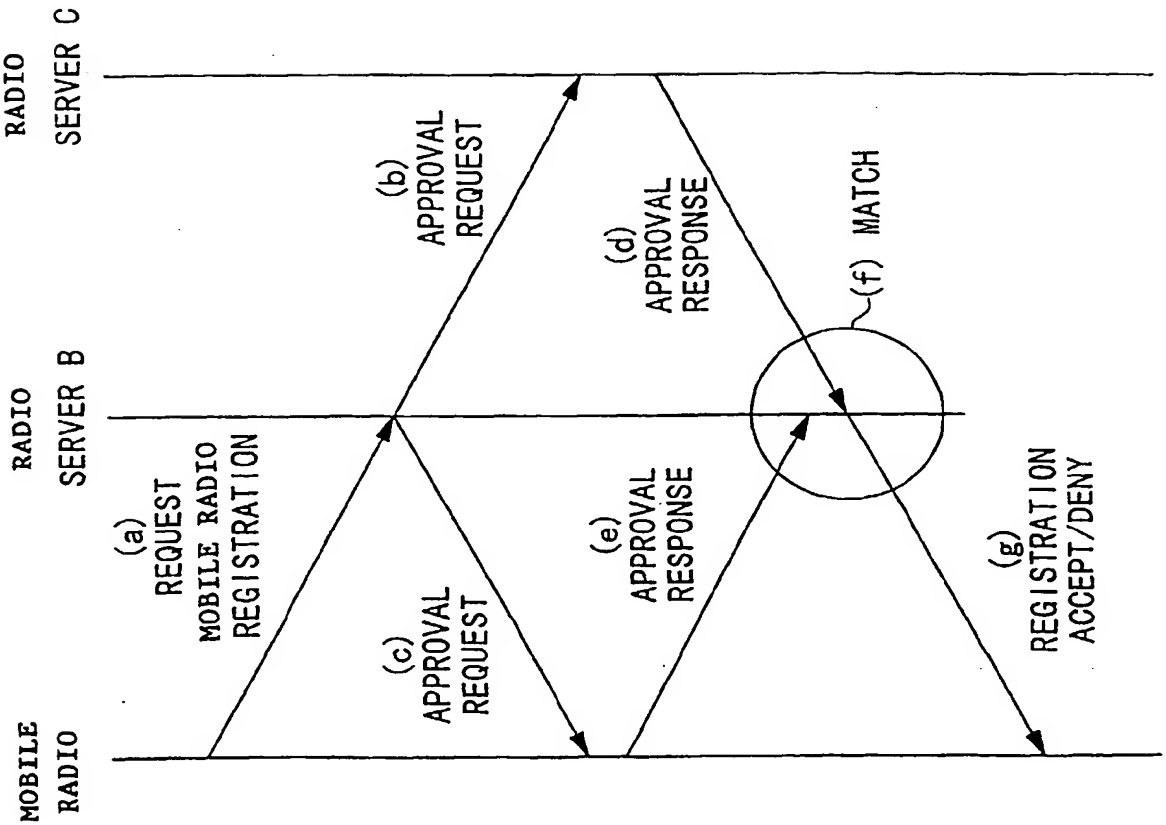


FIG. 10

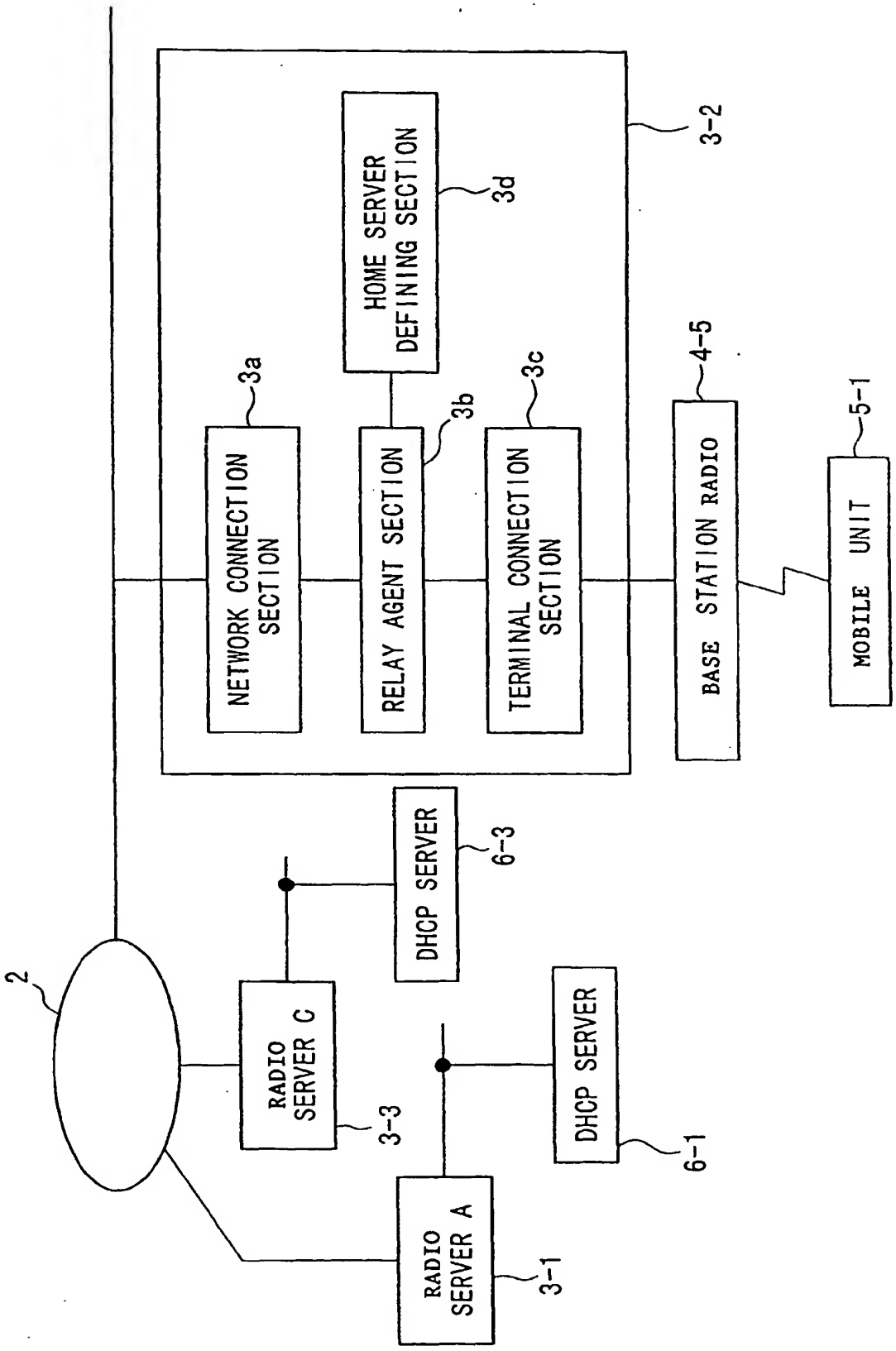
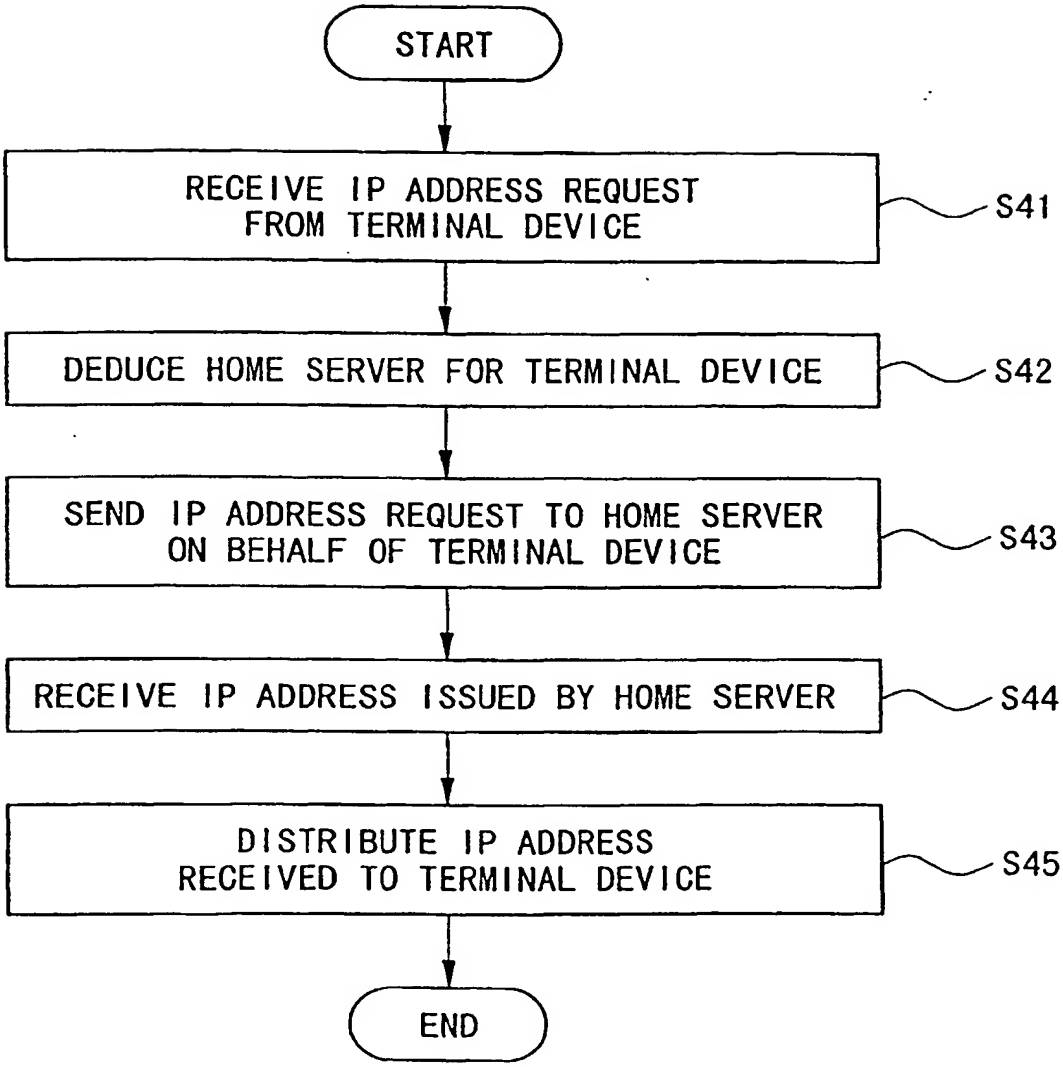

2
RADIO SERVER A
3-1
RADIO SERVER C
3-3
DHCP SERVER
6-1
DHCP SERVER
6-3
NETWORK CONNECTION SECTION
3a
RELAY AGENT SECTION
3b
TERMINAL CONNECTION SECTION
3c
HOME SERVER DEFINING SECTION
3d
3-2
BASE STATION RADIO
4-5
MOBILE UNIT
5-1

FIG. 11



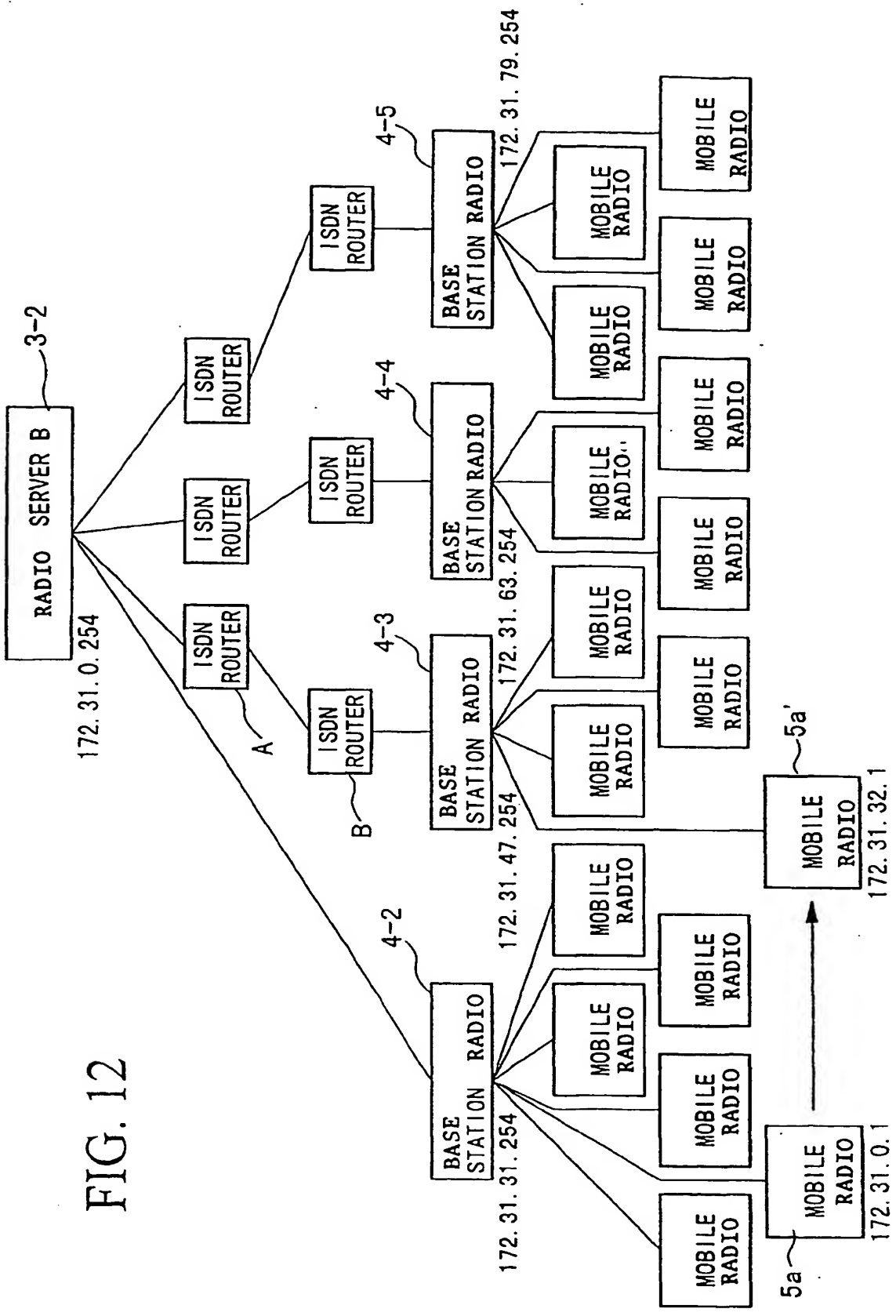

RADIO SERVER B
3-2
172.31.0.254
ISDN ROUTER
A
B
4-2
4-3
4-4
4-5
BASE STATION RADIO
172.31.31.254
172.31.47.254
172.31.63.254
172.31.79.254
MOBILE RADIO
5a
5a'
172.31.0.1
172.31.32.1

FIG. 12

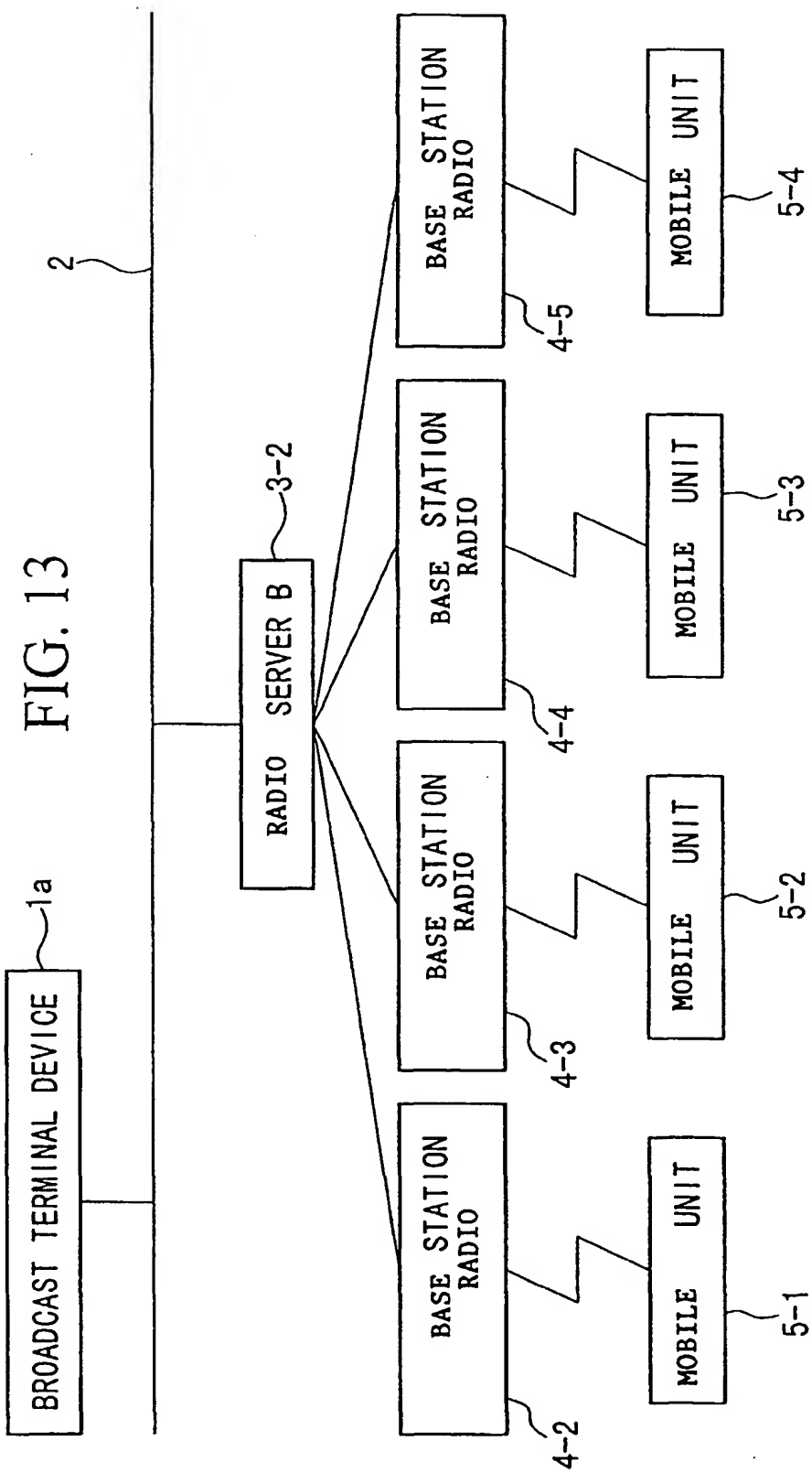


FIG. 13

FIG. 14

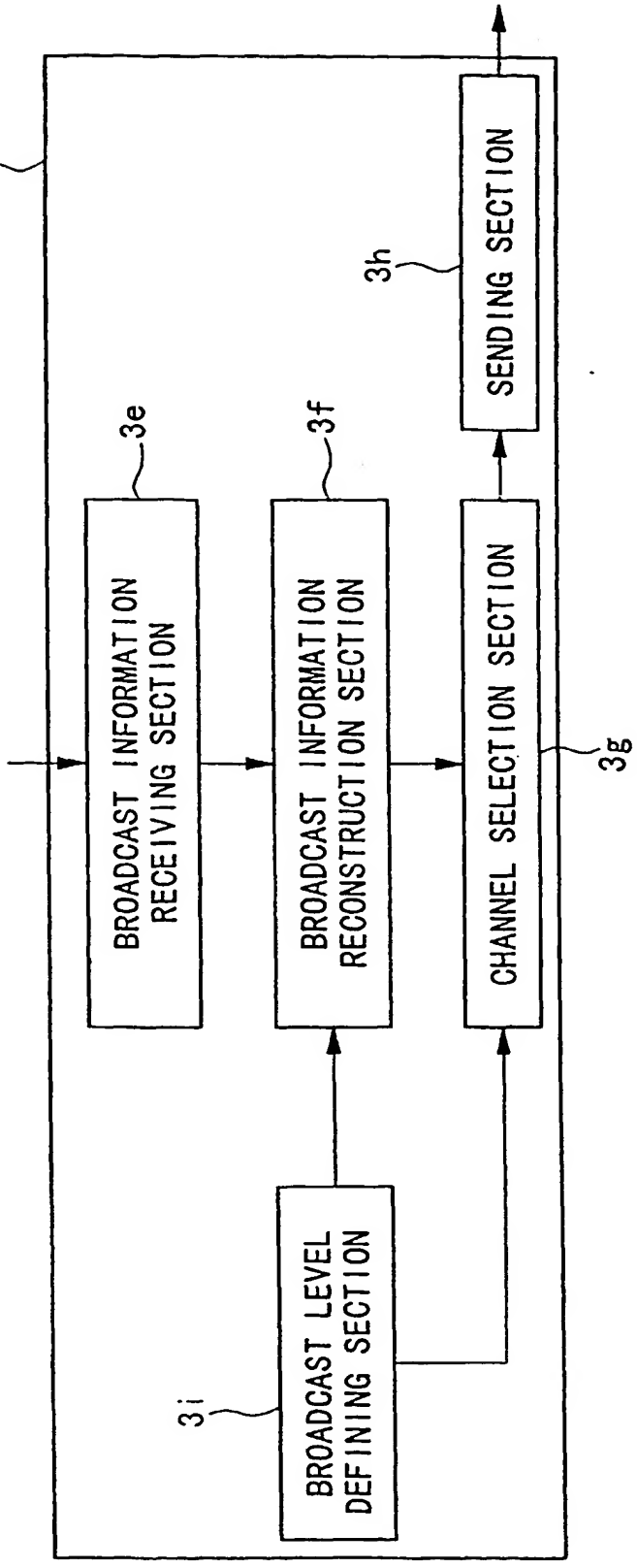


FIG. 15

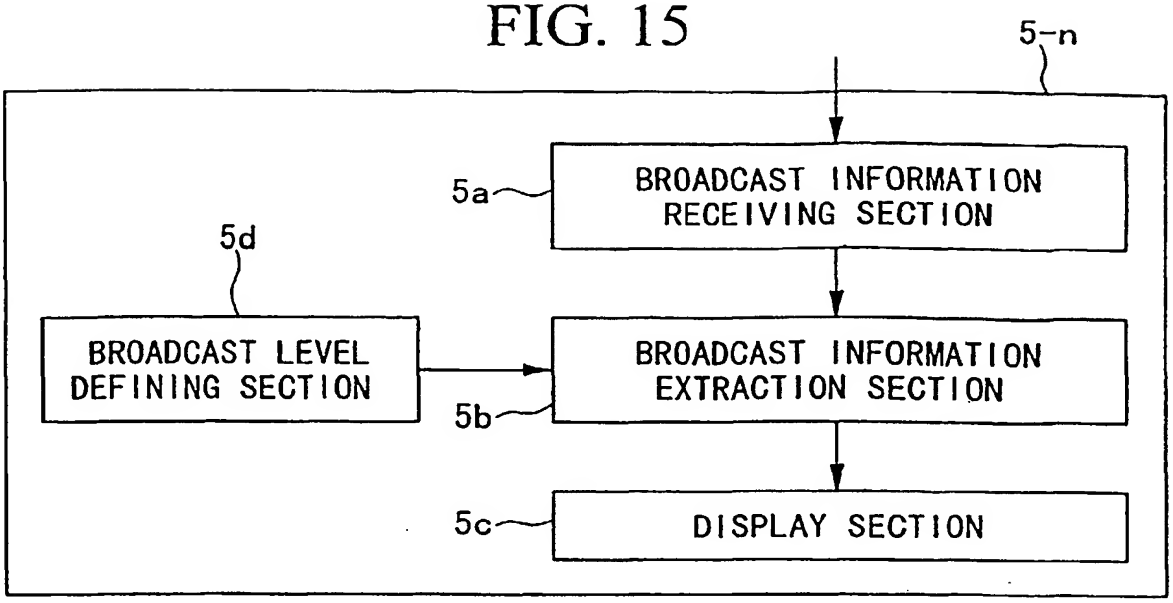


FIG. 16

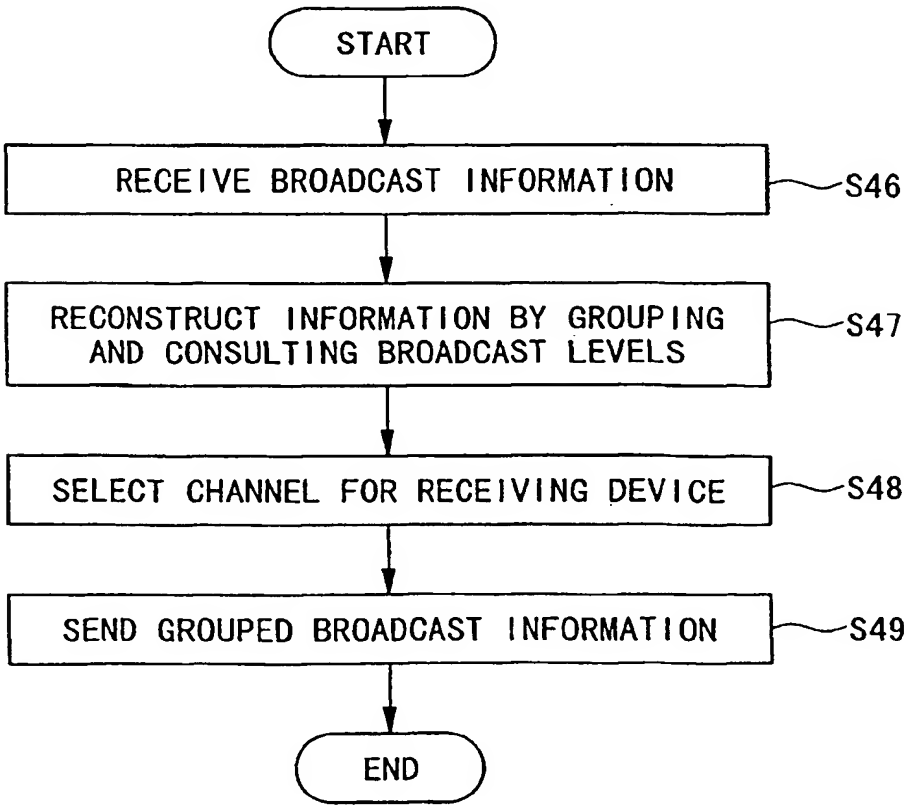


FIG. 17

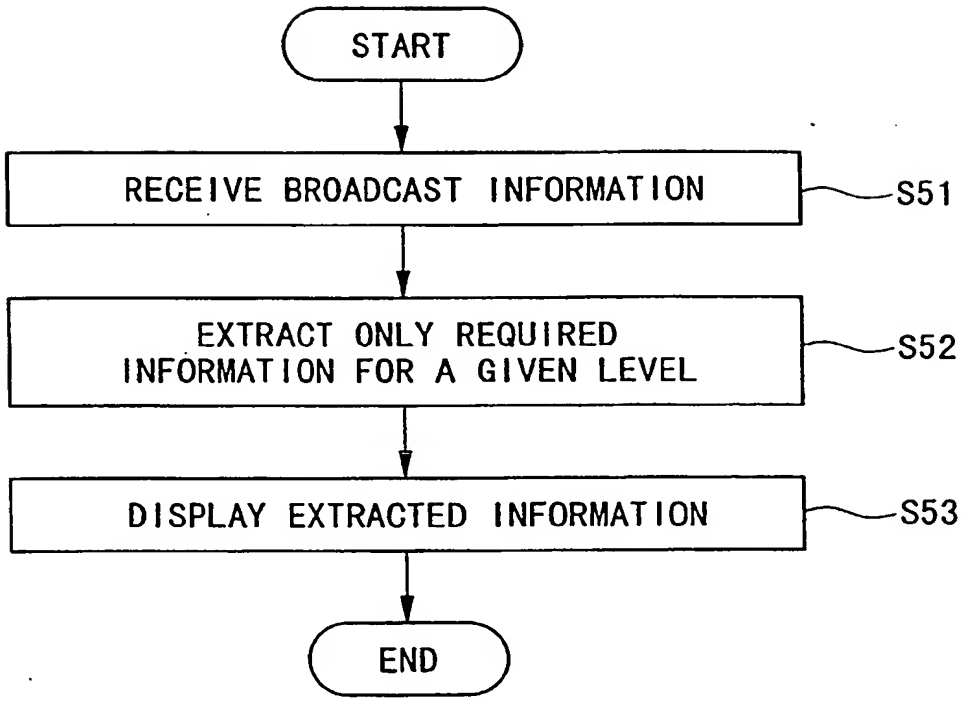


FIG. 18

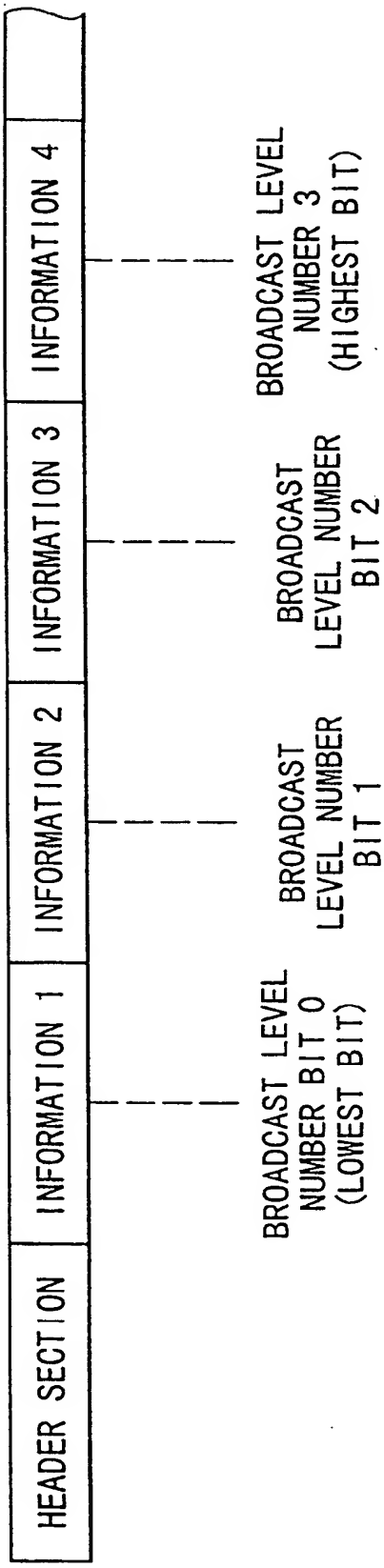


FIG. 19

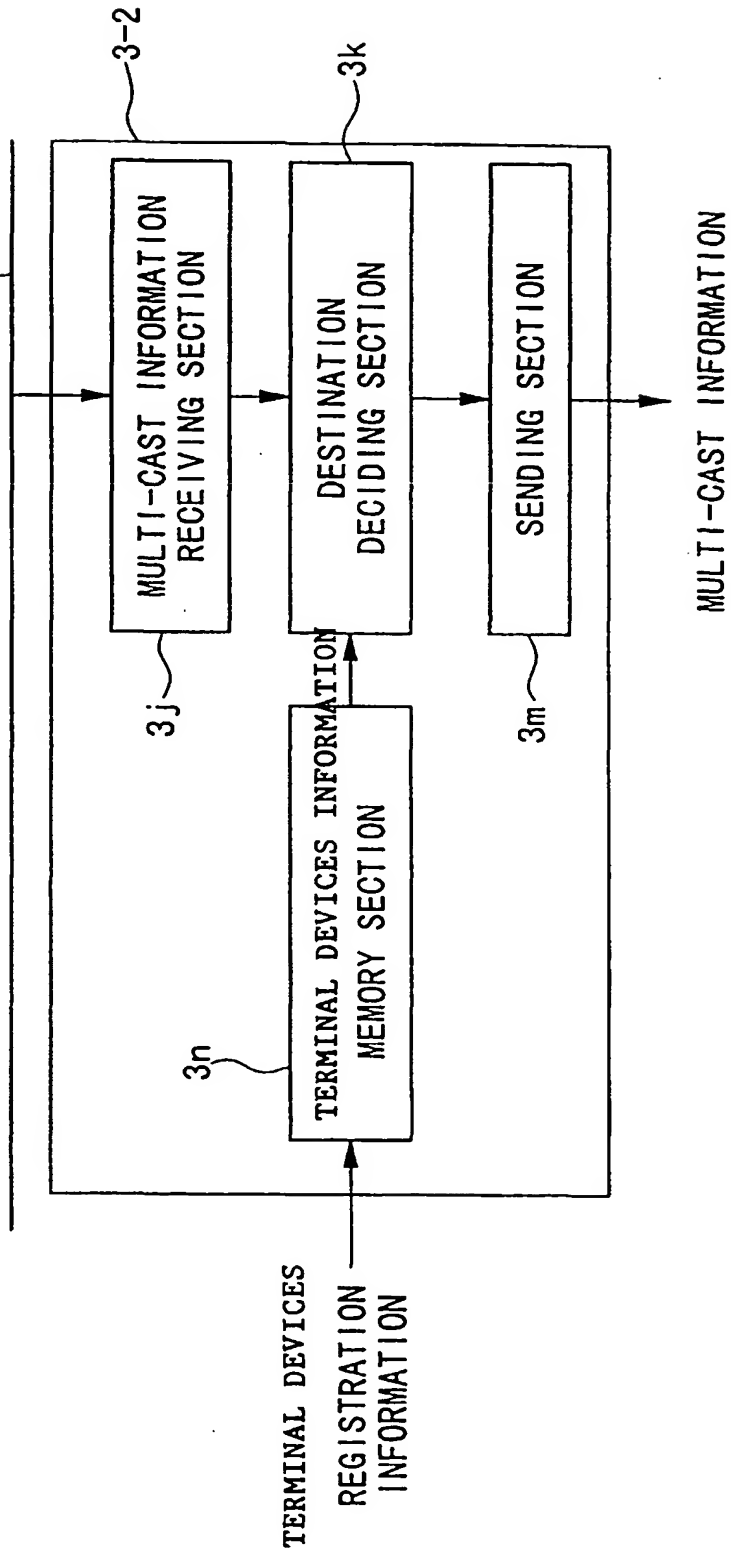

2
3-2
3k
MULTI-CAST INFORMATION RECEIVING SECTION
DESTINATION DECIDING SECTION
SENDING SECTION
MULTI-CAST INFORMATION
3j
3m
3n
TERMINAL DEVICES INFORMATION MEMORY SECTION
TERMINAL DEVICES REGISTRATION INFORMATION

FIG. 20

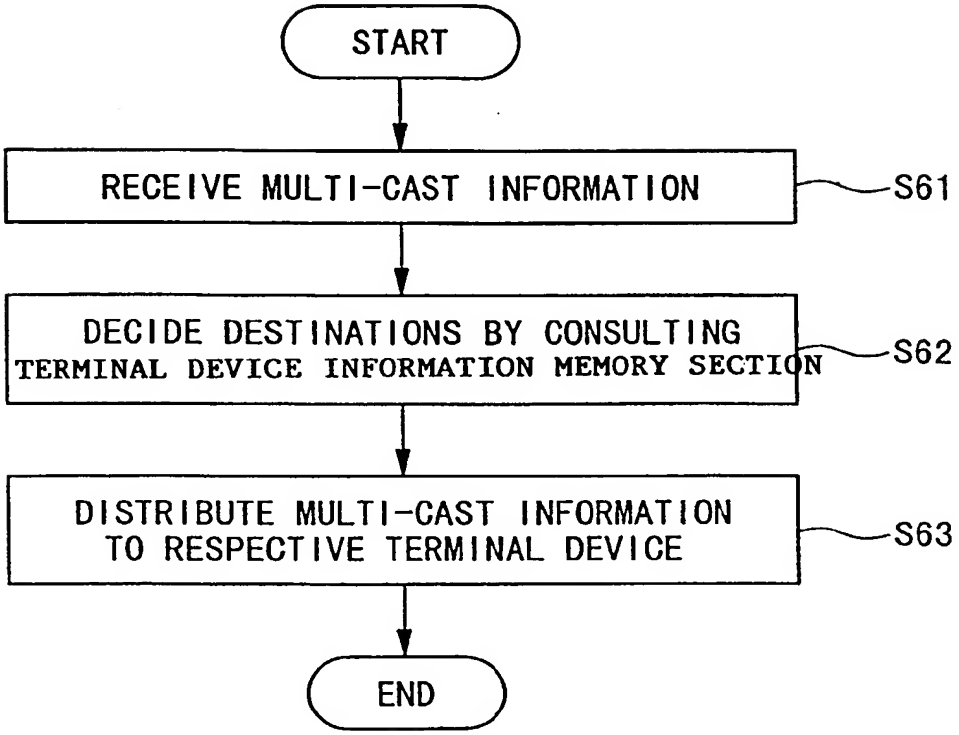


FIG. 21

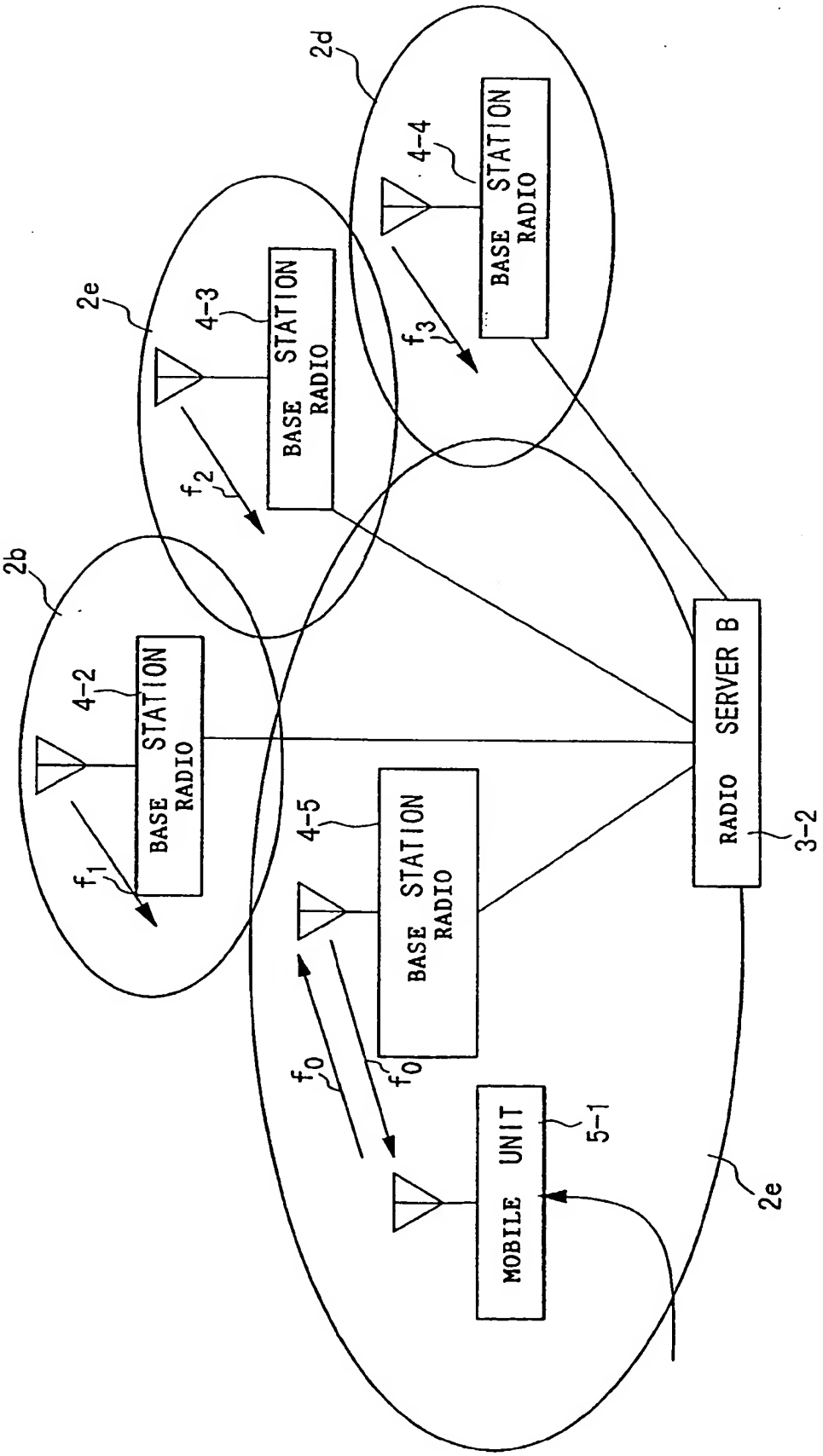

2d
2e
2b
4-4
BASE STATION RADIO
4-3
BASE STATION RADIO
4-2
BASE STATION RADIO
4-5
BASE STATION RADIO
f_3
f_2
f_1
f_0
f_0
SERVER B
RADIO
3-2
MOBILE UNIT
5-1
2e

FIG. 22

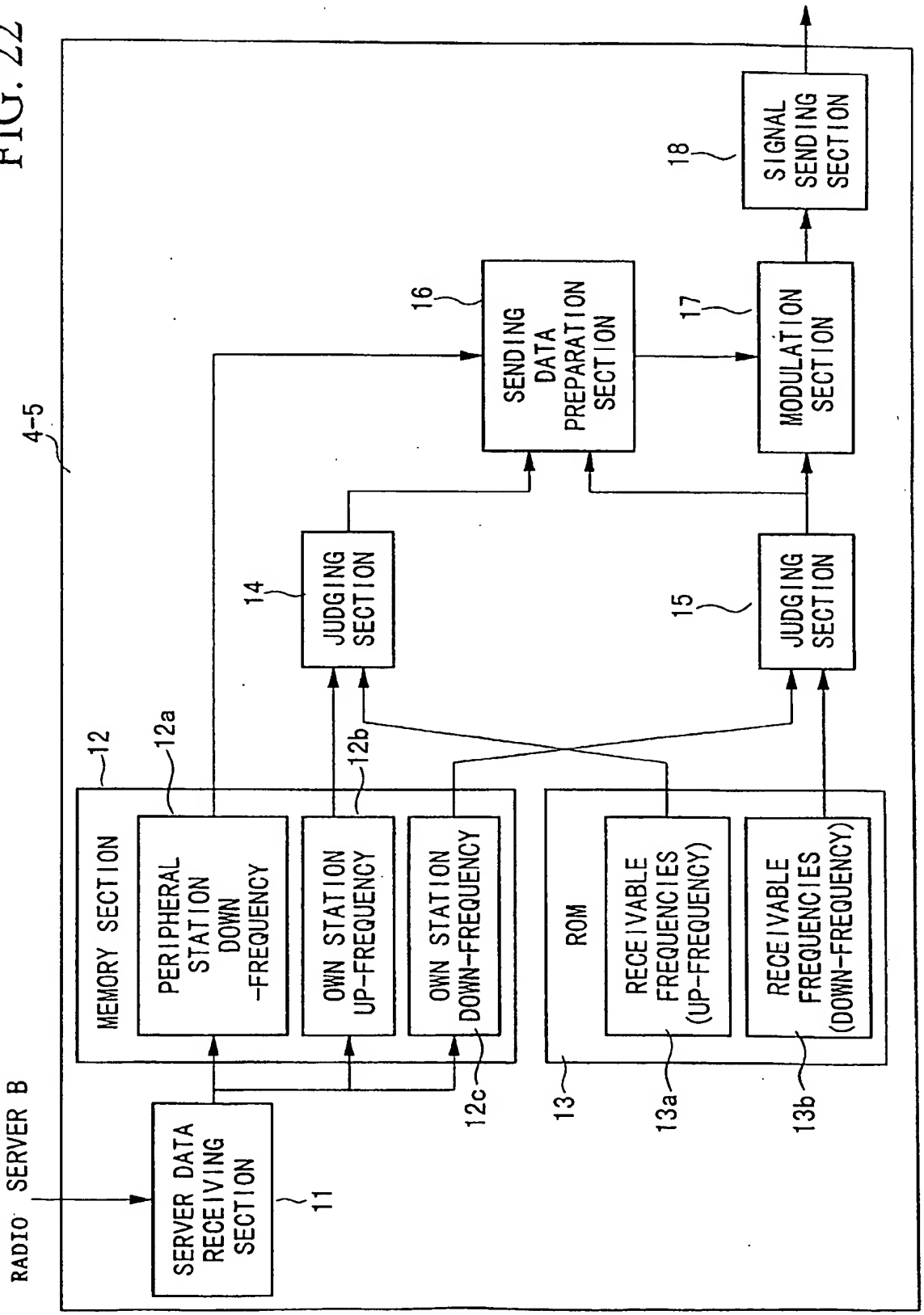


FIG. 23

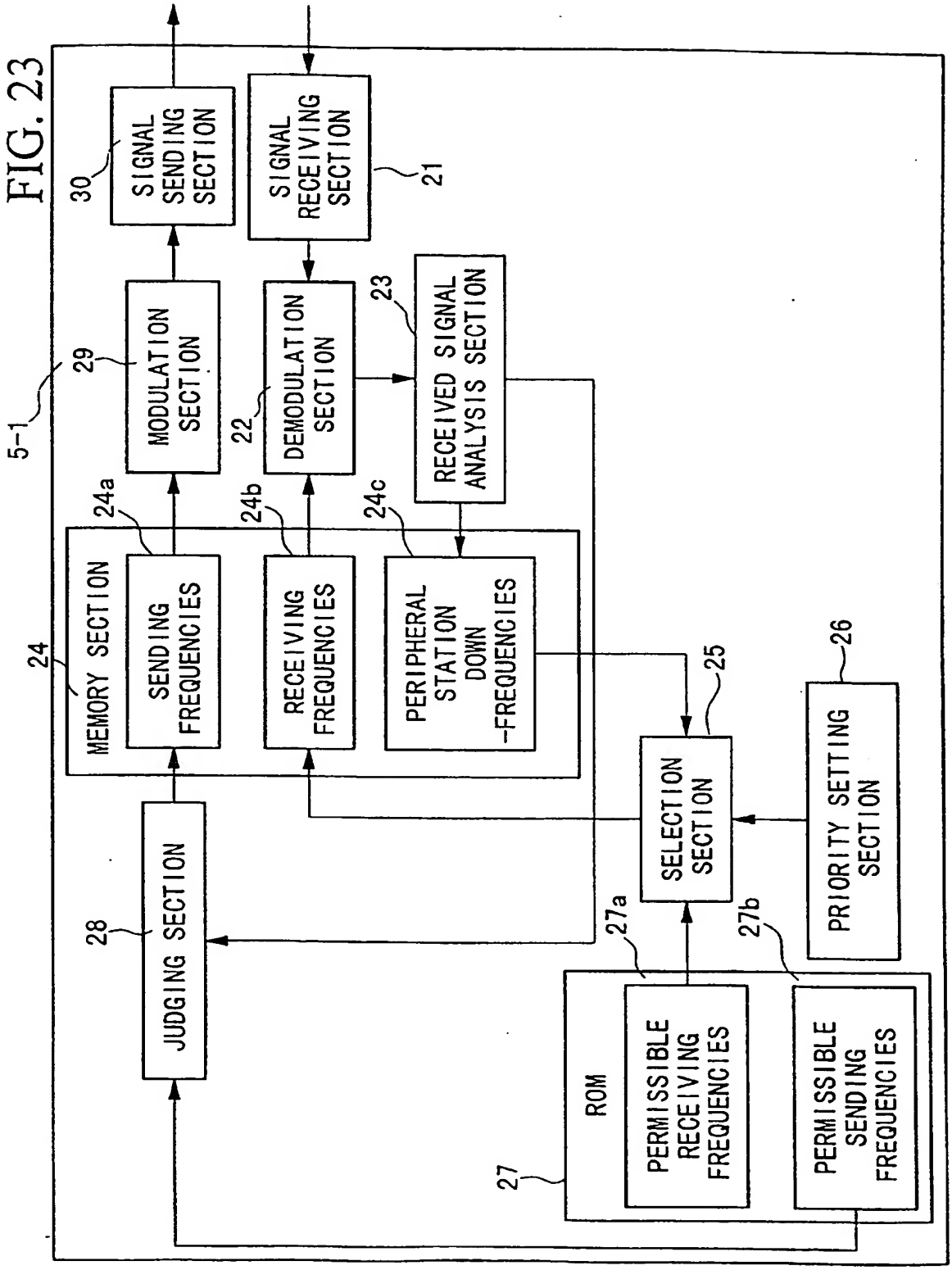

5-1
SIGNAL SENDING SECTION
30
SIGNAL RECEIVING SECTION
21
MODULATION SECTION
29
DEMODULATION SECTION
22
23
RECEIVED SIGNAL ANALYSIS SECTION
24a
24b
24c
24
MEMORY SECTION
SENDING FREQUENCIES
RECEIVING FREQUENCIES
PERIPHERAL STATION DOWN -FREQUENCIES
25
SELECTION SECTION
26
PRIORITY SETTING SECTION
JUDGING SECTION
28
27a
27b
27
ROM
PERMISSIBLE RECEIVING FREQUENCIES
PERMISSIBLE SENDING FREQUENCIES

FIG. 24

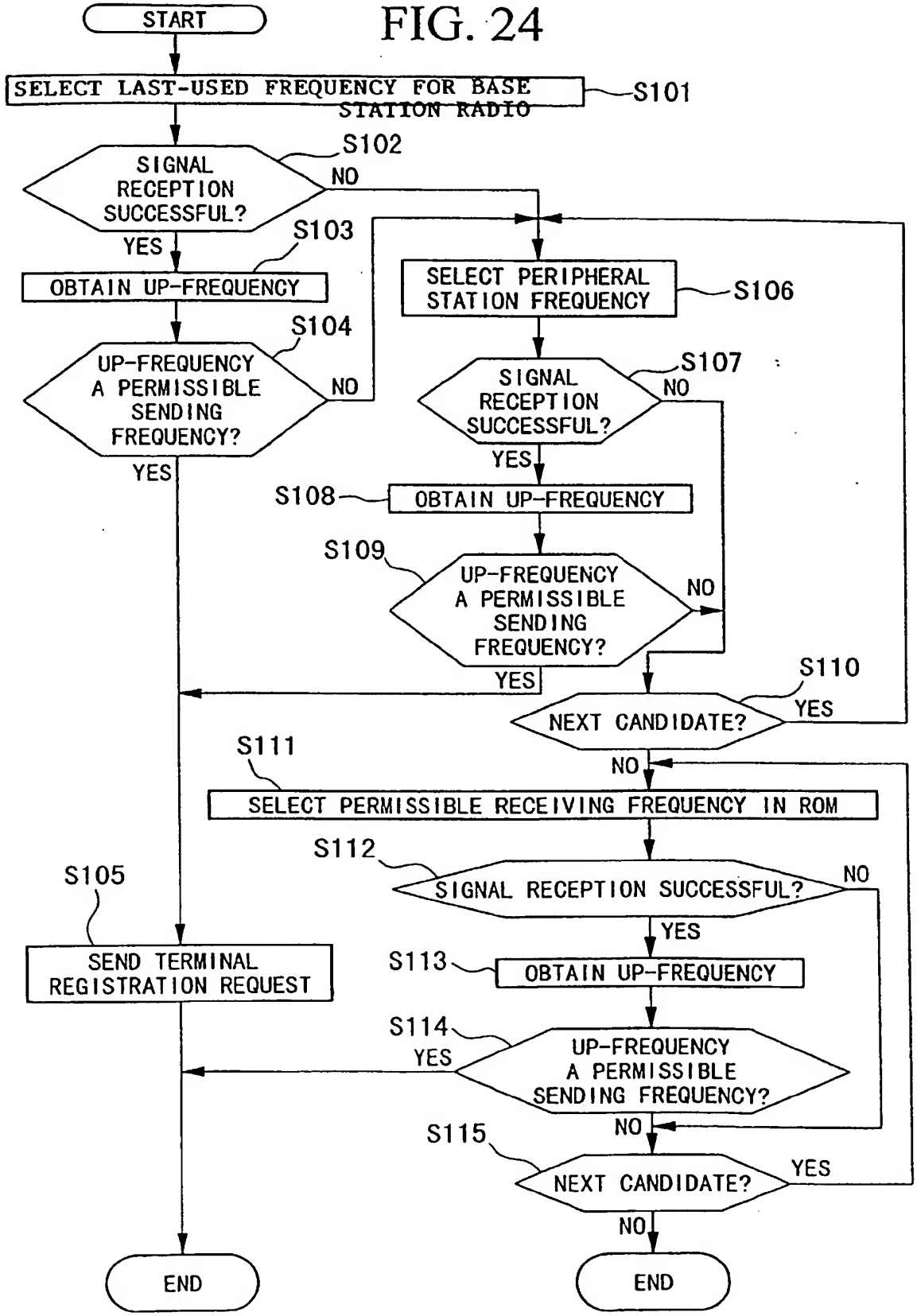


FIG. 25

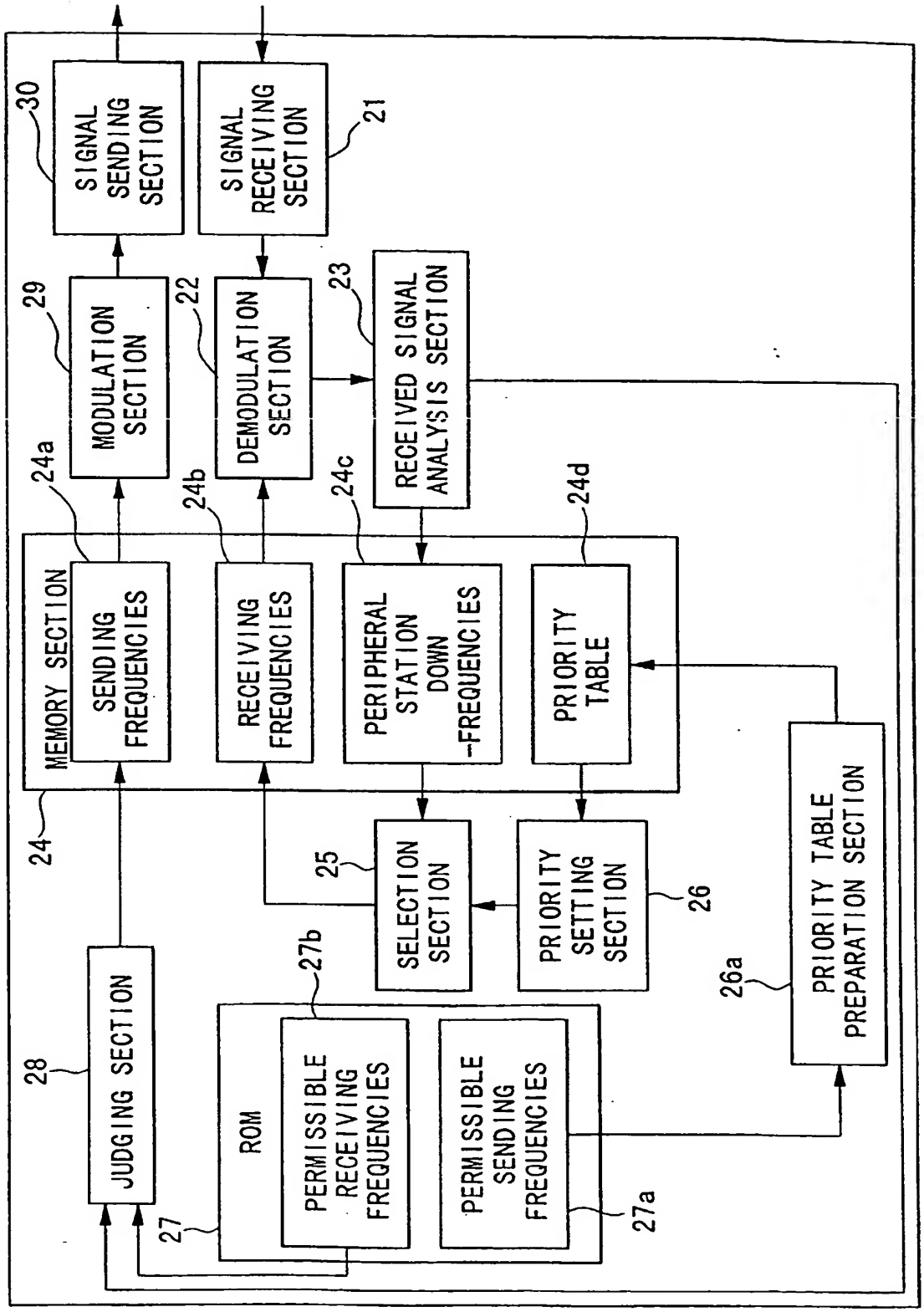


FIG. 26A

DISTRICT NAME	USEABLE CHANNEL NUMBER
a	1, 2, 3, 4, 5, 6
b	1, 5, 6, 7, 9
c	1, 2, 6, 7, 8
d	9, 10, 11, 12

FIG. 26B

CHANNEL NUMBER	PERMISSIBLE FREQUENCY
1	f1
2	f2
3	f3
4	f4
5	f5
6	f6
7	f7
8	f8
9	f9
10	f10
11	f11
12	f12

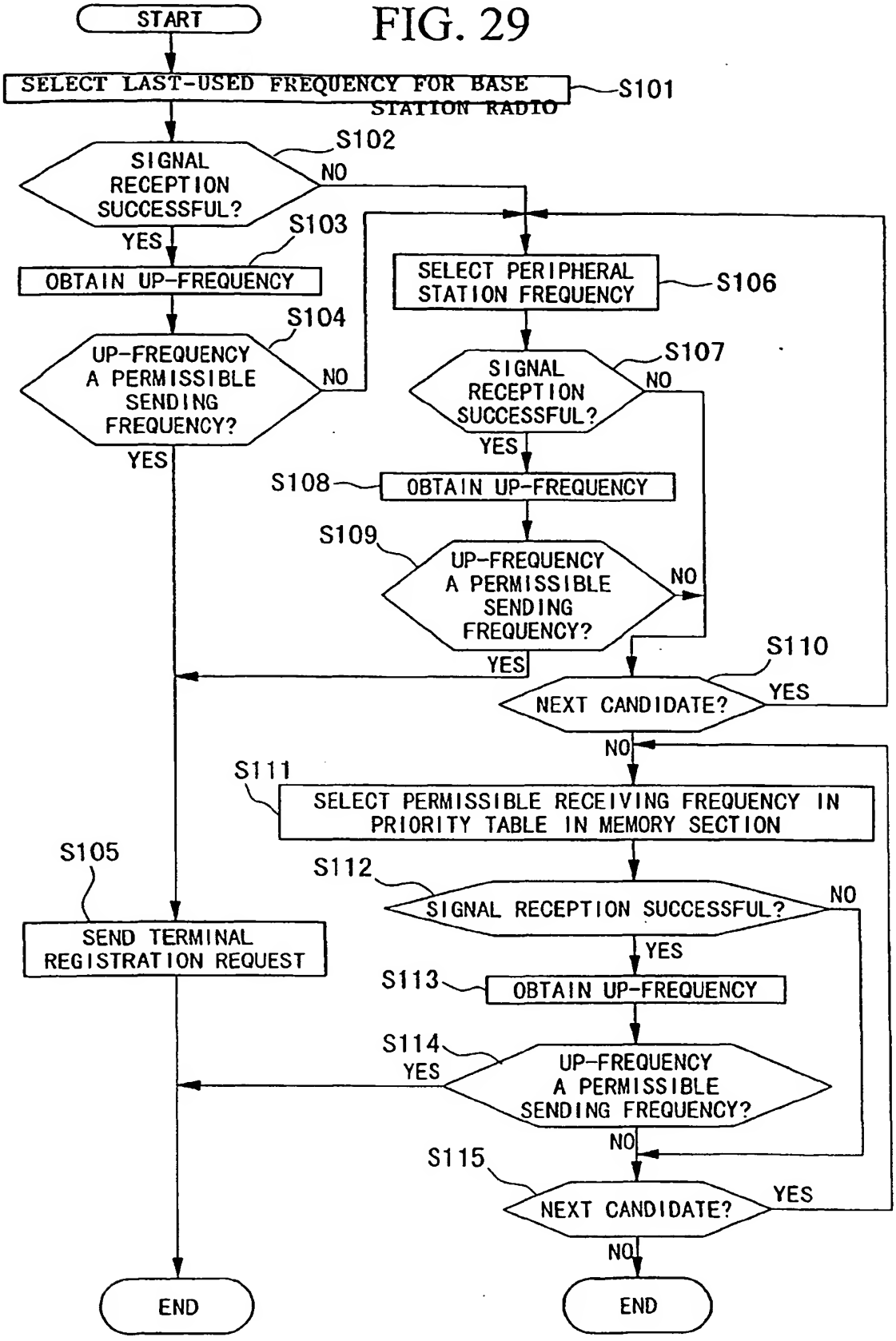
FIG. 27

CHANNEL NUMBER	OPERATING DISTRICT NAMES	NUMBER OF DISTRICTS	PERMISSIBLE RECEIVING FREQUENCY
1	a, b, c	3	f1
2	a, c	2	f2
5	a, b	2	f5
6	a, b	2	f6
7	b, c	2	f7
9	b, d	2	f9
3	a	1	f3
4	a	1	f4
8	c	1	f8
10	d	1	f10
11	d	1	f11
12	d	1	f12

FIG. 28

CHANNEL NUMBER	OPERATING DISTRICT NAMES	NUMBER OF DISTRICTS	PERMISSIBLE RECEIVING FREQUENCY
1			f1
2			f2
5			f3
6			f4
7			f5
9			f6
3			f7
4			f8
8			f9
10			f10
11			f11
12			f12

FIG. 29


START
SELECT LAST-USED FREQUENCY FOR BASE STATION RADIO
S101
S102
SIGNAL RECEPTION SUCCESSFUL?
NO
YES
S103
OBTAIN UP-FREQUENCY
S104
UP-FREQUENCY A PERMISSIBLE SENDING FREQUENCY?
NO
YES
SELECT PERIPHERAL STATION FREQUENCY
S106
S107
SIGNAL RECEPTION SUCCESSFUL?
NO
YES
S108
OBTAIN UP-FREQUENCY
S109
UP-FREQUENCY A PERMISSIBLE SENDING FREQUENCY?
NO
YES
S110
NEXT CANDIDATE?
YES
NO
S111
SELECT PERMISSIBLE RECEIVING FREQUENCY IN PRIORITY TABLE IN MEMORY SECTION
S105
S112
SIGNAL RECEPTION SUCCESSFUL?
NO
YES
SEND TERMINAL REGISTRATION REQUEST
S113
OBTAIN UP-FREQUENCY
S114
YES
UP-FREQUENCY A PERMISSIBLE SENDING FREQUENCY?
NO
S115
NEXT CANDIDATE?
YES
NO
END
END